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January 1953

SUN - SAND and SURVIVAL

*An Analysis of Survival Experiences
in Desert Areas*



ARCTIC, DESERT, TROPIC INFORMATION CENTER

AIR UNIVERSITY

MAXWELL AIR FORCE BASE, ALABAMA

ADTIC Publication No. D-102

SUN - SAND and SURVIVAL



*An Analysis of Survival Experiences
in Desert Areas*

by
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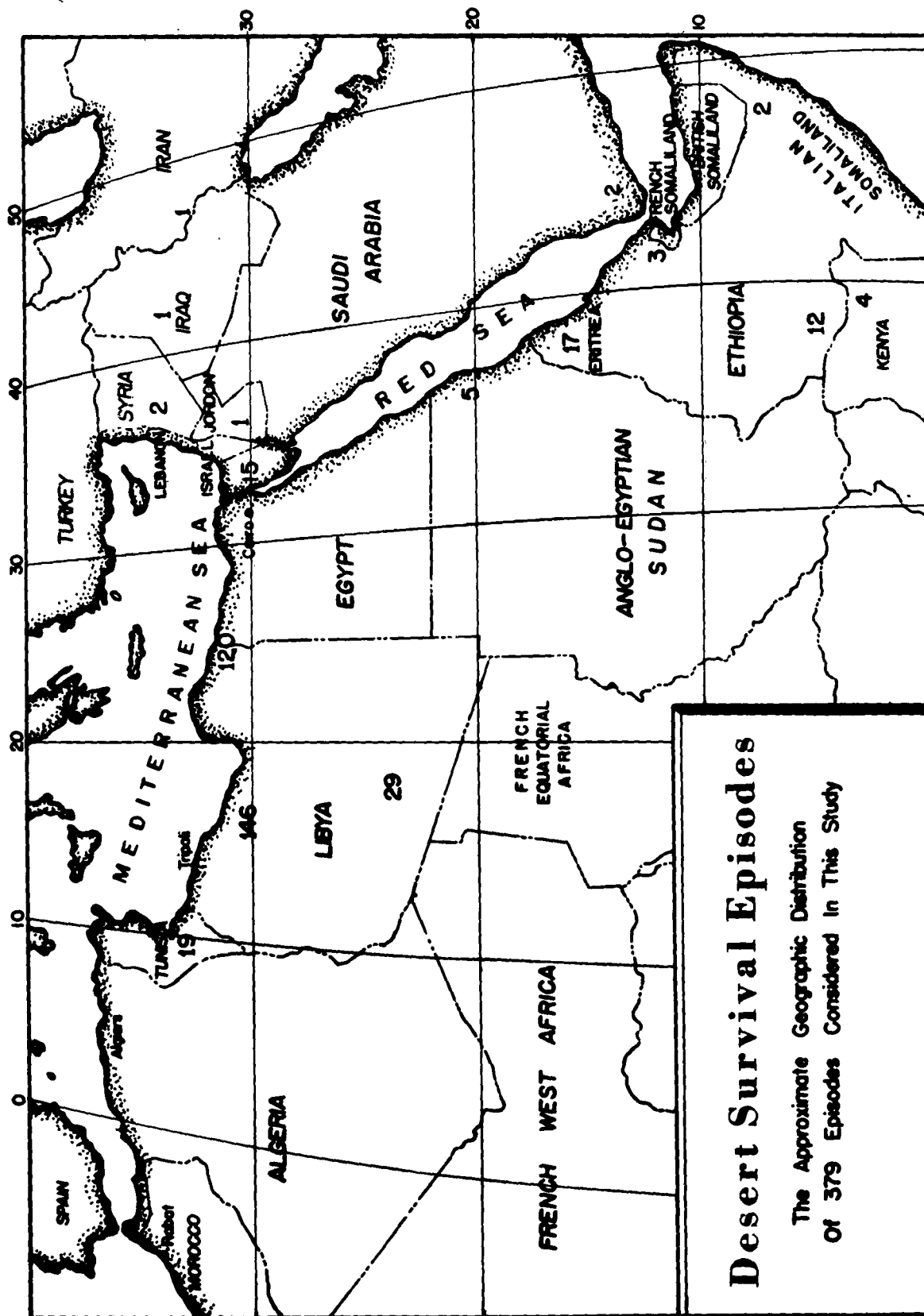
Preface

DESERT SURVIVAL presents unique problems not met in other nontemperate areas. Recognizing this, the Arctic, Desert, Tropic Information Center commissioned Dr. Richard A. Howard to assemble and analyze desert survival experiences of World War II, for the purpose of increasing our knowledge of desert survival techniques and procedures. To know what World War II survivors did, what they thought, and what they recommended after having experienced desert survival conditions is of paramount importance. *Sun, Sand and Survival* relates and evaluates these experiences.

Dr. Howard, ADTIC consultant, has had long experience in the survival training of military personnel. He is the author of the ADTIC Publication T-100 999 *Survived* which analyzes 1,000 tropical survival experiences. Dr. Howard's desert study analyzes 382 successful desert survival episodes and mention is made of an additional 142 individuals who were lost. The stories show how men without desert background or mental conditioning met their desert problems. They include examples of men who left their group and were never heard of again. In the light of our present knowledge of the water requirements of the human body, we know that many could have survived had they had a better understanding of the requirements imposed by the desert. More survivors would have returned in better health and endured less discomfort if advance knowledge had been readily available.

Sun, Sand and Survival will contribute materially to the briefing of pilots and crews who operate over desert terrain. It gives firsthand information on what to expect in a great variety of desert areas. It shows definitely that deserts are not all alike. Used in connection with ADTIC Publication D-100 *Afoot in the Desert* and Air Force Manual 64-5 *Survival*, it gives the reader a thorough grasp of techniques and procedures of desert survival.

PAUL H. NESBITT
Chief, ADTIC



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PART I

THE EPISODES

1. Background for the Study

THE MILITARY OPERATIONS of the United States Air Force over desert terrain took place primarily in the opening phases of World War II. At that time our forces were scarcely organized for the activities they were to undertake. Briefing for desert operations was inadequate; survival training had not been organized; survival manuals were not yet written; emergency equipment was not available either to be carried in the aircraft or to be dropped to survivors on the ground; and rescue organizations to locate and return the survivors were still to be formed. However, men flew over deserts and some of them came down on desert terrain and walked home to tell about it. The experiences of these desert survivors have now been studied and it is felt that analysis of these experiences will give some indication of what problems men must face in desert emergencies.

This study is a topical approach to the problem of desert survival. The stories forming the basis of this study represent first-hand experiences of men who walked the desert. The things these men saw, the problems they faced, the hazards they endured, and their adaptations, improvisations and solutions to their problems will be considered under such topics as navigation, health, rest, shelter, and hazards of the environment. This study has been requested by the Directorate of Requirements of the United States Air Forces. It is hoped that the study will prove useful not only to the program of instruction in survival procedures conducted by the USAF throughout its field of operation but to operating units of the Air Rescue Service, the preparation of rescue kits and materials, and the compilation of survival manuals and specific information on areas where the USAF operates today. I have tried to prepare a readable account of what the airmen of 1940-43 endured in the desert with the

knowledge that today's fliers can learn from the difficulties as well as the determination, stamina, and ingenuity of the men who lived these stories.

The British Air Force in conjunction with units from New Zealand and South Africa began military operations against the Italians in the desert areas of East Africa in 1940. These operations spread to the western deserts in North Africa against the combined Axis forces the following year. With the entry of the United States into this global conflict, small units of the AAF joined the Desert Air Force in North Africa and were incorporated into the DAF. Urgency demanded that many of these American units receive their desert training cooperatively, and it was only after several months of such training that the Ninth Air Force was established as an independent operational unit. With the invasion of Morocco and Tunisia the USAF came into its own as an operational force and remained that way until the defeat of the Axis forces in North Africa. The Allied air units, operating from the east and the west, experienced desert conditions of the most severe type. In addition to the fighting units the transport planes of the Air Transport Command also flew routes over some desert areas in Africa.

The desert was left behind as an active theatre of operational warfare when the attack shifted to southern Europe and the invasion of Europe began in Sicily in 1943. From 1943 until the end of the war in Europe, only a few outfits operated over desert areas.

The desert training center in southwestern United States was not used to any great extent by the USAF in preparation for the war in North Africa. Only a few survival stories have been gleaned from training operations over the North American deserts.

2. Nature of the Sample and Sources of Material

It is considered desirable to limit the scope of this study to experiences of military men, primarily Air Force or flying personnel. A great deal has been written about desert areas by explorers and commercial travelers who have had emergency experiences in deserts. However, all of these men had a background for the area and were mentally if not physically prepared for the desert. It is felt they would not represent the same sample as the airmen or soldiers who survived in the desert.

The period during which these events occurred was also unusual, but one that was to be expected in wartime. The number of men and vehicles operating in the desert regions was certainly abnormally large. The chances of encountering patrols or attracting passing military aircraft represented conditions not duplicated by explorers who were isolated. Military men, for example, who could often depend on water from the radiators of abandoned vehicles in the desert or who found rations on the vast sands of the desert certainly had a different set of chances of survival than the casual traveler of today or a generation ago. For these reasons the stories considered in this study are the experiences of Air Force personnel as they occurred in wartime.

The stories were taken from the period of 1940 and the British operations against the Italians in East Africa until the collapse of the Axis forces in North Africa. Only a few stories occurred after 1943.

The stories used vary considerably in detail and completeness. The intelligence reports of interviews with survivors are much inferior to those available a few years later. Military records of the early phases of the war in North Africa are scanty and in many cases woefully inadequate. What stories are available are often clouded with the effects of military censorship. The time and specific location of the episode are lacking all too frequently, yet this information is extremely important in analyzing the actions of the survivors. The type of aircraft flown determines the number of men involved in any episode as well as the amount and na-

ture of emergency equipment that can be carried; this information is generally not available.

The records of air operations in North Africa, both of the American forces and of our allies, as available in the Air University Library and in the Historical Archives, were searched to obtain the basic material used in this report. In addition the published reports of war correspondents, individual war stories, unit histories of our own and allied units supplied material. Military and civilian periodicals published during the war offered some stories, and where possible detailed accounts of these episodes were traced back to the squadron records of the particular unit involved. From the squadron records the names and addresses of men involved in the survival episode as survivor or rescuer were obtained. It has been possible in the last year to contact many of these men or their families to piece together more details of specific survival stories.

The records of the British, South African, and New Zealand forces in the African theater of operations have been extremely valuable. I only regret that more material was not available on the activities of the Long Range Desert Patrol which rescued so many desert evadees. The Late Arrivals Club with its membership of 365 at the end of 1942 would be an additional wealth of information if more men could be contacted. I have interviewed about 15 American members of this organization.

Through the kindness and cooperation of many Air Force reserve and active military units, interviews have been conducted with groups and with individuals who had emergency survival experiences in the African desert during the 1940-43 period. I am extremely grateful to all who cooperated in this study for making available their records and in some cases reliving a painful experience they wanted to forget.

The analysis covers 382 individual successful survival episodes. Involved in this study are accounts of 142 additional men who were lost, strayed, or died en route. It is impossible to determine what percentage

this might represent of the total number of men who went down in the desert during this period. Only 15 of 365 members of the Late Arrivals Club of 1942, men who walked back from desert landings, are included in the study. In 1944 the Air Transport Command recorded 24 persons lost over desert areas in their operations and that 12 of them survived. It is worth noting in this case that 10 of the 12 men were from 1 of the 8 planes involved. The details on these cases could not be located. Even in the cases studied it is not possible to safely say what percentage survived. Some of those reported as missing in action were prisoners of war. The episodes studied may be relatively small in number but they represent a great variety of experiences in many types of terrain, under varied conditions, and from a miscellany of aircraft.

Specifically, these survival episodes occurred in Algeria, Morocco, Tunisia, Libya, Egypt, Transjordan, Syria, and Iraq, Iran, Saudi Arabia, Ethiopia, Kenya, British and Italian Somaliland, and the southwestern United States. There are additional large desert areas of the world in which no military operations took place or for which no military survival stories were found. The deserts of Australia and the vast deserts of Central Asia are not represented in these episodes.

Desert survival occurred under the most hazardous of conditions in extremely diffi-

cult terrain. The stories reveal a tremendous amount of individual stamina, for the desert required stamina and the original decision a man must make to evade and not to surrender was a difficult one. He faced the obstacles of heat, lack of water, distance, and shortage of equipment. We know that one man gave up and surrendered to Italian forces in North Africa only after 14 days of evading. During this time his bare feet had become so bruised and infected he could no longer stand on them. This individual, however, buried himself in a trench in the sand to give the rest of his party 24 hours' head start before he turned himself over to the enemy.

A sergeant pilot of the Australian Air Forces bailed out of his damaged plane with wounds in both legs. He used his parachute to tie up his wounds and then crawled for 5 days and nights before he reached a patrol which rescued him.

A desert march of 510 Ethiopian troops from the Rio Omo to Maji is almost a classic desert survival episode but is not considered in this study. These men, cut off by Italian forces, marched 17 days before they were spotted by Kenya patrols and rescued. They were without provisions after the third day and eked out an existence by foraging off the land. Eventually the party became too weak to hunt and were in poor shape when rescued, but in the 17-day trek only four men dropped by the way.

3. Reasons for the Emergency.

DESERT EMERGENCIES occurred for a variety of reasons. Enemy action caused the majority of descents, directly or indirectly. Faulty navigation and subsequent lack of fuel ranked a close second. A flight of nine planes from the Ferrying Command landed in the desert in 1942 some 500 miles off course. This particular episode was never explained in the reports examined, but the lack of landmarks in the Egyptian-Libyan desert troubled a great many fliers. Wells, oases, and depressions reportedly all looked alike. Areas of operation were poorly mapped and in many cases navigation had to be based on tracings from Baedekers of

the area. Four crews reported themselves lost without landmarks in a sandstorm somewhere over the Egyptian desert, and ultimately a lack of fuel forced them to abandon their ships.

Mechanical failure was reported in about 10 percent of the cases studied. With no facilities for salvage of the aircraft, the pilots realized it was a matter of making their own repairs or destroying the plane and walking back to the base. One pilot who was having fuel supply trouble made an emergency landing behind the Axis lines. As he tried to repair his fighter, he noticed the approach of an Italian truck.

He started the engine again and flew several miles at a low altitude before power failure again forced an emergency landing. This time he was approached by a German patrol, and once again he took off and flew as far as he could. This time, fuel exhausted, he landed behind Allied lines. His desert experience consisted primarily of burned

hands from working with his hot engine and sun-heated wing surfaces. Another pilot reported he made seven forced landings before returning to his base in Egypt.

Icing conditions led to one emergency crash landing in Algeria. Two crews were forced down by mechanical failure of their aircraft in sandstorms over southern Libya.

4. Nature of the Emergency Descent

IN THE STORIES AVAILABLE, parachute landings following bail-outs and emergency crash landings appeared with equal frequency. However, most men who made parachute landings concluded after the survival episode that, where practical, crash landings would be preferable.

Parachute landings were generally successful and without incident. Only two accounts of broken limbs could be found and both of these involved legs. One flier whose parachute harness was defective landed with such force he was partially paralyzed for 24 hours. Some serious abrasions, bruises, sprains, and other injuries resulted from the terrain on which the men landed. Those who landed on relatively smooth rock surfaces or sandy areas were usually free of injuries. The greatest number of minor injuries occurred in southern Libya and the Sinai desert in areas of large and numerous boulders. The accounts from East Africa where shrub vegetation was more abundant report many scratches and sprains due to descent into the thorn scrub. Eleven accounts were found of men landing near the edge of the Qattara Depression in Egypt; all describe the difficulty of landing in such terrain. One man, descending too close to the edge of this depression with its steep and rugged cliffs, tried to slip his chute for directional control and landed instead on the slope of the cliff. His chute only partially collapsed against the cliff and he was dragged over about 500 feet of extremely rough terrain.

Parachute descents during sandstorms were particularly hazardous. Two men who bailed out over a sandstorm reported they were buffeted about by the wind, tossed in all directions, sometimes gaining altitude

and sometimes descending. Another man in a similar predicament reported he was violently airsick for the first time in his life before he reached the ground. The force of the wind and the abrasive effect of the sand carried by the storm peppered the legs of one man with pellets so that he could hardly stand when he reached the ground, and another claimed his face was raw and his hands bleeding when he landed.

Finding the crash site of the abandoned aircraft or getting together with other crew members proved to be extremely difficult for those men who bailed out. A group of three men from a British bomber bailed out as close together as possible and, while all three evaded capture and reported back to their squadrons, none of them had seen any of the others in the course of 4 days' travel over the open desert.

Most of the men who parachuted from aircraft reported they at least made an attempt to locate their abandoned plane. One group of seven men searched for 3 days before finding the crash on the morning of the fourth day. Attempts were made to locate the planes primarily as a source of emergency supplies. A few men indicated they knew they should destroy the aircraft if possible. I could find stories of only 37 men who reportedly stayed with their aircraft until rescued.

Crash landings were generally made without difficulty in the daytime. Bail-outs occurred primarily at night or under storm conditions when crash landings were considered too risky. Wheels-down landings were reported in 36 instances, indicating the terrain was such that men could plan a landing. Wheels-up landings were more frequent in occurrence.

One thing is clear from the stories studied: desert landings can and should be planned. All too frequently the men reported they stretched out their last ounce of gasoline and then landed with a dead engine or abandoned the plane just as it went into a glide. Many of these pilots regretted the lack of control at the last minute due to lack of power. Two crew members ordered to bail out while the pilot attempted a dead-stick landing reported the plane went into a spin or dived into the ground. Generally a lack of choice in a landing site was the most serious failing in dead-stick landings. The conclusion was often drawn in the reports that with a few more gallons of gasoline a safer landing could have been made. All agreed that dead-stick landings in desert terrain are dangerous.

Successful planning when the mission seemed at an end was well demonstrated in many stories. Terrain was selected for the landing, instructions were given for bracing and safety of crew, loose or heavy objects were jettisoned, exit hatches were removed, or other safety precautions taken when ample warning was given. The survival of personnel once on the ground was also correlated with the preemergency planning in a dozen stories. In one of these episodes a B-24 was nearing the end of its fuel supply and was flying at 11,000 feet.

The pilot passed the word around that emergency bail-out was in order and instructed the crew to amass all emergency equipment. Each man managed to eat a handful of vitamin pills before the bail-out, although this procedure was hardly necessary. More important, each man in this crew carried a canteen of water on his person when he left the plane. One man bailed out with a .45 and a flashlight in his hands and retained them when he hit the ground. Another stuffed his shirt full of oranges and carried others under each arm. The oranges outside his shirt were lost in descent, but this crew had oranges for breakfast in the desert! Instructions were given to the crew that all except the pilot and co-pilot, the last men to leave the plane, were to walk north. Pilot and co-pilot would walk south to meet the group. All of the men landed safely and, following the pilot's instructions, the entire crew was assembled by noon the following day.

Planned bail-outs seemed to have better success in placing the individuals reasonably close together on the ground. In one particular episode six men landed within 400 yards of one another. In another the men landed in two groups of four, although 8 miles apart. In a less well-organized emergency exit, the crew of a light bomber were scattered over 12 miles of desert.

5. How Men Saw the Desert

DESERTS are usually defined as areas so deficient in moisture that they are unable to support a vegetation necessary for man to live. There are hot deserts and cold deserts, but the current study considers only the former type. Hot deserts occur primarily in tropical or semitropical belts. They are characterized by extreme changes of temperature, generally hot days and relatively cool nights. Rainfall in such areas is usually seasonal and occurs in torrential downpours. The terrain of hot deserts varies, but most of them have porous substrata which are altered into vigorous and active land forms by the occasional rains. The humidity is generally low and the sky

cloudless. Both transpiration and evaporation are rapid. The high atmospheric pressure characteristic of desert areas is responsible for the constant winds found there.

Men who survived in desert areas had much to say about them, good and bad. Deserts to some were dry, lonely and unfriendly places, but to others the desert in spring was beautiful because it produced beds of flowers in wadis. The oppressive heat of the summer contrasted with the bitterly cold fall nights on the Cyrenaica plateau and with the winter season's freezing cold winds of constant gale force. The land was described as a monotonous sea of nothingness except for the

hummocks of shrub growth, so flat that an escarpment or wadi gave physical relief out of all proportion to its size. The floor of the desert was hard-packed sand to some, to others solid smooth rock like a paved street, loose shifting dunes in undulating folds, a coarse formation of flinty flakes which tore the shoes, or a coal pile of black boulders from the size of tennis balls to massive rocks as big as houses. The men cursed the heat, the cold, the mirages and illusions, the constant wind that carried sand into their food, eyes, nostrils and mouths, yet

they had time to admire and wonder at the small kangaroo mice which leaped away at their approach or the myriads of mosquitos and flies that appeared from nowhere to disappear again as rapidly. Survivors even commented on the false dawn of the west, the speed with which the sun rose, and the perfect sunsets over the desert flatness.

This study is based on the stories of men who learned about the desert the hard way, yet lived through their experiences to tell about them.



PART II

THE PROBLEMS OF SURVIVAL

1. Travel in Desert Terrain

a. The Long Walk

THE STORIES of desert survivors are primarily those of men who walked out. The decision to travel or not to travel in the desert campaign was one based on military necessity. The men did not expect search parties or rescue organizations to look for them. Rescue organizations had not yet been formed and what searching took place was organized by other men in their own squadrons. Most survivors fully expected in all cases of emergency action under study to make their own way back to their bases. Significantly, very few men stayed for any length of time near their downed aircraft. If the emergency landing had taken place behind enemy lines or in proximity to military activity the decision had to be made quickly. Many men, especially among those interviewed, decided to surrender to the Axis troops rather than face the prospect of a long or suicidal hike across the desert. This was not always due to fear; in many cases it was the only action available to the individual because of a lack of equipment or water or the fact that the men were injured and needed medical attention.

Generally in North Africa the decision was made quickly. Two courses of action predominated. One group of men planned to walk parallel to the coastal road and approach the British lines eastward. The other group headed south into the desert in an attempt to contact wandering tribes of Arabs, the Long Range Desert patrols known to be operating there, or to come to an oasis which they knew was visited periodically by Allied forces.

If the emergency had occurred far away from the fighting front, considerable time could be taken to organize the trek. The crew, if it had been scattered in parachute descent, could be gathered together. Injuries could be treated and a few hours of

rest taken. The wreckage of the plane was located when possible for salvage of anything useful for the desert trek. Supplies were distributed for equal weight loads and routes carefully planned. Command was designated or assumed, and travel and ration plans settled.

When a Wellington bomber crashed a short distance south of Tobruk behind German lines, the crew of six headed into the desert immediately. Their plan was to parallel the coast and walk east to the British lines. They walked for 29 days and covered 350 miles before they were through. One of the party was forced to surrender because of infected and painful feet. Another of the party was killed when the evadees came upon a German truck at dawn one morning and saw the driver asleep on the ground. They decided to capture the truck and ride back to their lines, but unfortunately the back of the truck was loaded with sleeping German soldiers and one man was killed in the melee which followed their attack on the driver. The rest of the party escaped, however, and four men returned safely.

In the far eastern part of Africa another British bomber crash-landed in Ethiopia. The crew of six was shaken up and one of the men injured his foot in the landing. After burning the plane the six started walking. Their supplies consisted of 2½ gallons of water and a small amount of food. They walked all that day and through the night, navigating at first by compass and then by the stars. The second day the heat became so unbearable they could only walk for 15 minutes at a time across the alternating bands of rough lava and soft shifting sand. After covering 10 miles in these short walks of the second day, the party stopped in the shade of a solitary tree to rest until sunset. At dusk they started again but could only walk for an hour and a half before exhaustion set in. They started again

the next morning but walked only until nine before one man collapsed exhausted. As they were now down to 6 pints of water, they talked over the situation. It was decided to divide the water and the three stronger men would go on, even in the heat of the day. These three were never seen again. The weaker and slower three continued walking as their strength permitted, sometimes for 10 minutes at a time, again for 100 yards before resting. They passed 4 days at this slow speed before it was necessary to stop in the shade for 2-days' rest. The ninth day of their survival episode they started out again, 10 minutes of walking and then a rest. After three spells of this they were all exhausted. Defeated, they returned to their tree to rest in the shade. They had been without water for 4 days and their tongues had started to peel. Later that day they were sighted by a passing plane and rescued.

From the stories available of men who walked back, the majority had easier times and went shorter distances. The average length of time spent walking or evading was 5 days, but periods of 20 days or more are not uncommon. The party out for 29 days represented the longest period of unaided desert survival in the stories collected.

In the 103 cases studied where the travel distances were given and seemed reliable, the greatest distance covered by a group of survivors was 350 miles and the average around 50 miles. At the beginning of his survival experience, an uninjured man in average territory seemed to be capable of walking 12 to 18 miles a day. One story, reliably documented, reports that a man covered 50 miles in 24 hours. As the survival episode continued, with heat and lack of food and water taking their tolls, the distance he covered became shorter. Generally this was noticeable around the fifth day, and by the fourteenth day many men were down to 1 to 2 miles a day.

A captain of the Royal Army Medical Corps became isolated from his outfit in the Western Desert and walked 140 miles in 11 days. He carried 60 pounds of rations, water and gear. He usually hiked from 8:30 p.m. until 3:30 a.m., covering 12 miles in

this time. If he continued to hike until 8:00 a.m. his distance for the 11½ hours was 18 miles.

The story showing the most stamina was that of an Australian sergeant pilot who was shot down in his Kittyhawk. With both legs wounded he bailed out of his aircraft and landed in the desert. He used his parachute to bind up his wounded legs but found he could not stand on his feet. So, knowing his need for medical attention, he crawled day and night, dragging his legs, for 4 days and nights. He found that by night he was so exhausted he couldn't sleep and so he kept crawling. He reached the point of exhaustion on the fifth day and found that his mind was beginning to wander. It was on the fifth day he was found by a desert patrol. He had been without food or water for the entire period.

One admonition appeared frequently in the survival stories: if you have no idea where you are, stay put until you do. You are better off near the plane, or making short treks to establish your locality, or waiting until nightfall to determine directions. Do not begin aimless wandering while completely lost in the desert.

In some cases a crew reached immediate agreement and course of action. In other cases plans were talked over for considerable time before a decision was reached. In a few cases the plan was dictatorial on the part of the pilot. Only in a very few cases did groups break up and go in different directions.

The decision to walk back to Allied lines was made for one group of airmen. Their situation on crashing near El Alamein seemed so hopeless that they walked to the nearest German outpost, waved a white shirt and surrendered. The Germans received the group, gave them directions to British lines and sent them off. It seems the German outpost had been cut off for 36 hours without water and communications and they wanted no prisoners or additional members in their party. It took the men 3 days under artillery fire to reach the British lines but they did, much chagrined at their situation.

Considerable difference in practice was

found in the time of day when traveling was done and in the amount undertaken. Traveling by night had its advantages in the Egyptian and Libyan deserts. The terrain was usually open and navigation was possible by the stars. The nights were more pleasant and the land cooler. In fact the nights were often cool to the point where many men expressed the necessity of wrapping their parachutes around them to keep warm even while walking. The disadvantage of traveling at night was the inability to see immediate objects. In the boulder-strewn areas this proved painful in stubbed toes and barked shins. One man even fell into a wadi and received some painful bruises. Without the proper signaling equipment it was impossible to signal at night to attract passing aircraft, and identification of camps, vehicles, or planes was difficult. Desert mechanized patrols rarely operated at night so that contact with them was not possible. Survivors reported that while they covered greater distances at night they were always afraid they would pass some critical landmark, a well, or a friendly base.

Traveling by daytime in the Egyptian-Libyan desert area also had disadvantages. The principal one was the extreme heat. Not only the direct rays of the sun but the hot winds and the hot terrain bothered various survivors. Visibility was also affected by a ground haze in the middle of the day and by mirages. Both of these hampered travel and signaling. Generally most men in the Egyptian-Libyan desert area found it most satisfactory to travel in the early morning hours around dawn until the heat of the day set in, and then again in the late afternoon.

The stories from East Africa were evenly divided between those who walked at night and all night and those who walked only in the day. Several groups indicated the density of the thorn brush, the painful spines, and the chance of encountering animals made them decide to travel in the daylight hours.

An unfortunately large number of men walked continuously from the time of the descent until they were exhausted. While this initial effort covered a great deal of

territory, these men suffered in the long run. Collapse came more quickly the second time, and the distance covered and walking time decreased rapidly with each collapse from exhaustion.

The effects of the heat and the sun and the continued exertion took its toll on many. Four men who started walking in the southern Libyan desert dropped one by one until only one was left. When he was picked up some 10 days and 210 miles from the spot where he had started he was out on his feet and did not even see the rescue party. He was lifted bodily and placed in the truck and when he recovered hours later he was still convinced he could have reached his destination, some 80 miles farther on.

By far the best procedure seemed to be to establish a regular pattern of walking and resting depending on the capabilities of the individual or the group. The most frequently adopted plan was to rest for half an hour following every hour of walking. A few men adopted a practice of walking half an hour and resting 15 minutes, and a few who walked in the day walked until noon and rested from 1 to 3 hours before walking again.

Specific hints on travel in desert areas were given by the evadees. The most frequent suggestion offered was that of watching the color of the terrain very carefully. These men pointed out that the nature and consistency of the substratum, and therefore the footing, could be determined by the color of the land. In Syria the areas of loose sand which were difficult to traverse were red. In southern Libya specific warning was given against the black areas called "sabahas," which were soft and afforded only difficult footing. Coastal sands in North Africa were particularly condemned as areas for walking. The survivors described their paths along these areas as "plod, plod, plod." In open desert areas several men gave warning against walking too close to bushes. Bushes generally had areas of soft sand at least on their lee side, and a path too close to these bushes slowed down a man's speed. In the Egyptian-Libyan desert area warning was also given against chotts, salt lakes, and crystalline-

covered swamps. These areas are not only difficult to traverse but are dangerous. The chott may be covered with a crust 2 to 3 inches thick, with a few inches to many feet of soft mire underneath. Salt lakes and chotts caused severe salt burns, alkali burns on the feet, legs and even hands of some men who tripped and fell in such areas.

Warning was given about wadis or gulleys in the northern deserts. One survivor had the rare opportunity of watching a wadi fill with a flood of water following a sudden and torrential rainstorm farther inland. He described this onrush of water as being $2\frac{1}{2}$ to 3 feet deep and approximately $\frac{1}{2}$ mile wide. He stated that in a matter of 2 hours the wadi was again completely dry.

A party of men in British Somaliland was successful in following a small stream to the coast, where they were rescued, but three parties isolated in the Western Desert area tell of difficulties in following dry stream beds. Apparently the wadis they followed led to depressions or sinkholes and the men were forced either to retrace their steps or to climb steep-sided slopes. Such blind depressions have no outlets and represent old lake beds or sinkholes in the desert.

When four American fliers were forced to bail out of their bomber following enemy action in North Africa, they met on the ground and surveyed their situation. Two of the men had leg injuries sustained on landing. The heat was severe and they had little water; nevertheless, they decided to walk east and parallel the coastal road. The footwear of this group consisted of flying boots, which they soon admitted was the poorest type of footwear for the trek they had undertaken. Loose rock on the area made poor footing and on the sixth day one man with a lacerated foot was forced to drop behind. On the eighth day another man left the party. The two remaining suffered from an intense sandstorm on the tenth day of their survival episode and were nearly drowned in a torrential rain on the fourteenth day. By the fifteenth day they had reached the edge of the Qattara Depression and decided to try and walk around this area to the north. The edges of the de-

pression formed such formidable terrain and such difficult walking that they then decided to cut across the depression. They descended the precipitous slopes of the depression and spent the eighteenth day walking across the lake bed. Here they found the going rough, for the surface of this lake bottom consisted of wave-like mounds of crusty sand and salt, each some 18 to 24 inches from the next. Two days were spent in the depression and by the twentieth day all suffered from alkali burns and their shoes long since had been wired together. On the twenty-fourth day they came to a large salt lake where progress was further impeded. Here they found the mosquitoes unbearable; they climbed again to the surface of the terrain surrounding the depression and were promptly spotted by a passing patrol and taken to their base. The men had covered 300 miles in their trek over some of the most difficult walking in North Africa.

One can conclude from the desert survival episodes that it is a poor practice to travel in wadis except for purposes of concealment or in a search for shelter and water.

b. Navigation

MEN who traveled the desert at night invariably oriented themselves by the stars. Those who traveled by day used compasses when they had them. Only one story was found expressing difficulty in using a compass and that took place in Ethiopia. The men concluded that a lode of ironstone rock produced enough deflection in their compass to take them 30 miles off their estimated route. Considering this story at the present time it is hard to believe that a lode of that magnitude exists. In addition 30 miles represents at least 1 full day's travel. One can conclude these survivors made the mistake of not checking their direction of travel often enough to recognize this deflection and probably they did not check their compass against the sun or the stars. It is of prime importance in any emergency travel to use all possible directional aids and to check one against the other frequently.

All survivors concluded that a compass

was a most necessary part of equipment for desert travel. Many said it should be personal equipment and carried on the wrist or in the pocket. A few suggested a compass be added to the escape kit they were issued. One man suggested in an official document that a small sextant be placed in every plane for emergency navigation.

Without a compass landmarks had to be depended on for local navigation. These led to difficulties in many cases. Mirages caused considerable trouble. Ground haze throughout the day obscured vision. Distances particularly are known to be deceptive in the deserts and survivors reported difficulty not only in estimating distances but also in estimating the size of objects. In southern Egypt one survivor reported that large boulders always appeared smaller than they were and in other cases small obstacles appeared insurmountable.

Survivors both in Saudi Arabia and in Tunisia warned that it is difficult to maintain a single landmark in navigation. Several groups reported they found it necessary to take turns keeping an eye on a specific mountain or peak or object which was their goal. Objects had a way of vanishing in some cases when the eye was moved for an instant, and in other cases so many peaks or hills looked alike that the individual could not determine which had been his original objective. In Tunisia specific warning was given of the frequent occurrence of twin peaks which on first glance seemed reliable landmarks. The men found after a short time of traveling that instead of one such landmark there might be several to a dozen twin peaks in the vicinity.

The Great Sand Desert, which was the emergency landing site of several groups of men, also caused navigational difficulties. In these rolling sand hills it was impossible to keep one objective in view and even their footmarks failed to give them a consistent path to look back upon.

The extreme flatness of other stretches of desert terrain in North Africa made navigation difficult. With absolutely no landmarks to follow, no objectives to sight, several parties reported they walked in

circles or large arcs before realizing their difficulties.

A marine pilot who made an emergency landing in the Arizona desert of the southwestern United States took all proper precautions of immediately spreading his parachute on the ground and putting rocks on the edges so that it would be most visible from the air. Then he decided to walk to his crashed plane at what he estimated to be a distance of 500 yards from his landing spot. He reached the plane to find it completely gutted by fire; then he was unable to retrace his steps to find his parachute again in the 5 days he spent wandering in the flat desert.

Navigational difficulties of a different type were experienced in Ethiopia, Kenya, and Somaliland by the British fliers. Here the density of the thorn brush, even though it was primarily acacia with small leaves, made it extremely hard to navigate from one point to another. In this area men resorted to following animal trails in the hope they led to rivers or water holes. Elephant trails seemed to offer the best and clearest route to the few men who reported them.

In the Sinai desert area and in portions of Egypt, travel routes were frequently used; fliers who found them just rested on the trail. One man encountered a camel caravan almost immediately after he hit the trail, although he reported it bothered him that he had not seen them approach, for they suddenly appeared out of a mirage. Another commented that it was awfully hard to be alone in his section of the desert, for in every direction he looked he saw wandering tribes, camel herds, or people watching him.

Two survivors independently suggested that survivors pay attention to the wind as an aid in navigation. One of these men on the Arabian peninsula noted that the wind blew consistently from the same direction. The other, in the Libyan desert, made the same comment and added that he was able quickly to judge his direction of travel by the angle at which the wind blew his clothes or struck his body. It may be possible in certain areas to orient oneself in relation to the

direction of the prevailing winds, once it is established that these are consistent.

c. Hazards of the Environment

MEN who walked across the North African deserts had much to say about the local environment and little of it was complimentary. The contrast of temperatures bothered them most of all. It was extremely hot during the day and often bitter cold at night, especially during the months of January and February. The bright sun was hard on their eyes, extremities, and skin. Blinding effects of the sun reflecting off the terrain caused many men to express concern regarding sunglasses. Several resorted to building fires and smoking their goggles in order to secure more protection against the glare. Several suggested that extra plastic colored slip-on lenses should be available to fliers for emergency use over regular goggles.

Light-skinned men tended to sunburn faster and more severely than darker-skinned men. A few commented that no amount of previous suntanning seemed to make any difference.

The heat affected their feet and hands. Survivors reported that the earth became so hot their feet were blistered through their shoes, and one man wanted to know if asbestos shoe soles of the slip-on or clamp-on variety were not possible. Exposure of bare hands to the sunlight resulted in painful burns. A few reported they found it necessary to walk with their arms folded and their hands in their armpits to keep their hands comfortable and protected. Placing sunburned hands in bare armpits apparently gave considerable relief, since armpits represented one of the few places on the body where the men could find continuous perspiration for cooling effect.

The persistent winds in the North African desert area seemed to have no cooling effect, and several men found that the constant blowing of the wind "got on their nerves." More significant is the fact that the constant winds usually carried an amount of sand or dirt particles. These particles got in eyes, ears, nostrils, and mouths and caused

irritations which were often severe. One story reports that abrasion of the eyes by the particles of dust reached the point where first the man's eyes watered so that he could not see, and eventually the watering stopped and only "emery cloth eyelids remained," making life very difficult for him.

Protection against dust and sand was obtained by survivors in a variety of ways. Strips of cloth bound round the head with small slits for visibility functioned like "snow goggles." Cotton, grass, cotton waste, bandage material were all used to stuff the ears. Cotton and axle grease were reportedly used in the nostrils.

Extreme winds blew up sandstorms which lasted from a few minutes to 2½ days, according to the survivors' experiences. Generally the survivors reported that they could see the approach of such storms and were able to take proper precautions; however, sandstorms completely surprised a few groups of men and led to navigational difficulties. None of the men who experienced sandstorms in the northern desert underrated the power and danger of such storms. Protection from the storms was uppermost in their minds, judging from the reports available. Most men found what shelter they could from rock cairns, natural ledges, boulders, depressions, or wells. A considerable number had time to dig depressions and rig a shelter of some sort from blankets, parachutes, or tarpaulins. A few men wrapped themselves in their parachutes and endured the storm in a prone position. Nearly all of these men had some comment to make on orientation before, during, and after a sandstorm. The warning was specifically given that it is necessary to mark your direction of travel adequately before the storm hits. A few men commented that when the storm was over they had no idea of which way they had been traveling and that all their landmarks were forgotten, obliterated, or indistinguishable. The general plan of marking routes prior to a sandstorm was to place a stick of some kind indicating direction. One man oriented himself with only one rock a few feet in front of the position where he lay. He commented that after the storm he learned that one point was not

adequate and recommended a row of stones, sticks, or heavy gear about 10 yards in length to give adequate directions following such an emergency.

Several parties reported they learned the hard way to keep their mouths shut in the desert. This was meant in two ways, that breathing through the mouth caused excessive drying and that talking not only got on the others' nerves but also caused excessive drying of the mucous membranes.

d. Mirages and Illusions

MIRAGES are common in desert areas. They are optical phenomena due to refraction of light by uneven density distribution in the lower layer of the air. The most common desert mirage occurs when the air close to the ground is much warmer than the air aloft, as during the heat of the day. Under this condition atmospheric refraction is less than normal and the image of the distant low sky appears on the ground looking exactly like a sheet of water. Distant objects may appear to be reflected in the "water." When the air close to the ground is much colder than the air aloft, as in the early morning under a clear sky, atmospheric refraction is greater than normal. When this condition occurs distant objects appear larger and closer than they actually are, and objects below the normal horizon are visible. In case the density distribution in the lower layers is such that the light rays from an object reach the observer along two or more paths he will see a distorted image or multiple images of the object.

Reports of mirages were very common in the survival stories examined. In most cases they were recognized as mirages and caused only minor difficulties. No story reported any illusions on the part of survivors that these mirages actually represented bodies of water.

The principal difficulties resulting from the aspect of mirages was that of traveling. Distances could not be judged because of

the lack of intermediate terrain, which was obscured by the mirage. Mirages hampered the vision and navigation to the extent that they sometimes concealed objectives in travel. In general it was reported that mirages "magnified some objects and concealed others."

One man hunting for animal food in the heat of the day reported that he no sooner sighted an animal than it ran into or hid in a mirage.

The lower layer of hot air which causes the mirage, commonly called desert haze, hampered vision and distorted objects. This was reported in several cases of signaling difficulties. Sighting a rifle on an object was apparently very difficult due to the haze low on the desert.

Several reports from survivors appear to be cases of imaginary illusions associated with the haze or mirage effects of the heat. One group was looking for a hill for a vantage viewpoint so long that the entire party began to see hills in all directions. They finally held a conference to iron out their difficulties and all settled on one hill which the group should approach. All men in the party reportedly saw the hill, and the group walked an estimated 9 miles looking for the hill which never existed and which eventually just disappeared into the desert flatness.

Dawn and dusk illusions also occurred and were reported in the survivors' stories. One group was severely troubled with the false-dawn spectral light on the western horizon. The fact that the sun at first appeared to be rising in the west caused anxious moments.

Another party contained one individual who claimed he saw a flashing beacon on the evening horizon. These men were in the Qattara Depression. The pilot explained the illusion by the occasional focusing of the light of a very bright star near the horizon through the residual heat waves of the cliff before them. But the one crew member was so convinced it was a beacon that he finally started walking alone to investigate this object and was never seen again.

2. The Problem of Water*

a. Amounts and Sources

WATER was the primary concern of men isolated in the desert. Some mention was made of water in every survival story studied.

The amount of water on hand at the time of the survival episode varied from none at all to as much as 10 gallons per person in the case of a large bomber which crash-landed. These men commented that 10-gallon containers were too large and heavy to carry over the desert with them and strongly recommended that no larger than 2-gallon cans be used as emergency supplies in the future.

It was impossible to draw any satisfactory conclusions on the length of time men were able to travel without water or with minimum amounts. Survivors reported they were without water from the start of their episode until they were rescued, but no duration of time would be stated. Five days was the longest case examined where the men stated they had no water and specified the length of time. Fourteen cases were studied where the reports stated the men had no water for 3 days.

The amounts of water various survivors had is also questionable. Canteens mentioned in the stories could have been quart, 2-quart, or gallon units. "Gallons" could have been Imperial or American units. "Cans," "bottles," and "jugs" are indefinable terms in the present analysis. Men stated they had "swallows," "small amounts," "the usual ration," or "a canful" of water. The temperature, conditions of exposure, and time of year are all variables in water requirements and are not clearly stated in the survival stories.

A few men commented that they were well hydrated before their emergency descent and others commented they wished they had been. Only one man stated it had been his practice to drink as much water as he could hold before starting out on a desert mission.

Water was carried on the survival trek in every imaginable type of container. Canteens were mentioned most frequently, but improvised containers from parts of the aircraft, tin cans, ration cans, jerry cans, bottles, covers to the aircraft, covers of first-aid kits, and even shoes were all pressed into service.

Generally the liquid drunk was water, but many of the British survivors indicated they preferred sweetened tea in place of water in their canteens. They felt the tea quenched their thirst more readily than plain water. A specific warning was given by one British survivor against having milk in the tea. He commented that the milk soon became sour and that it was impossible to remove that taste from the canteen during the rest of his survival period. One American flier reported he had not dared to leave his weekly ration of beer at the base and so carried it with him on his mission. He does not state whether this was an acceptable fluid under desert conditions. Wine was utilized by seven survivors, and two men reported they always "fortified" their canteens with whiskey before starting on a mission. Alcohol accelerates dehydration, but the bolstering of morale might have been a compensating factor.

Water was considered a precious item by all of the men involved in the stories studied. The supplies were carefully carried and zealously guarded. The doctrine of rationing (erroneous as it was) was well impressed on the flier during that period of war operations. However, rationing practices varied considerably. Some drank no water for as long as they could hold out. Some started from the beginning of the episode to form a habit pattern of drinking. The majority of those who commented reported they drank no water the "first day." Water was rationed one mouthful per hour, a mouthful morning and night, a mouthful at the end of each rest stop, or water only in the middle of the day. A few stories commented that injured men needed and were given additional rations. Three stories reported that leaders had difficulty in enforcing rationing,

*The reader is referred to pertinent sections of Air Force Manual 64-8 and ADTIC publication D-100, "Afoot in the Desert," for the latest information on water requirements.

but only one reported actual violation of rationing procedure.

The North African desert during the period of 1941 through 1943 offered a most unusual spectacle of abandoned and derelict vehicles due to the advance and retreat of both Axis and Allied forces. Survivors reported in great numbers that they had been able to get water from derelict vehicles, either from the radiators or from abandoned supplies. A British paratrooper of the Special Air Service was able to walk 200 miles using water from derelict trucks. This condition represents an unusual source of water for desert survival, yet the records of at least eight parties indicate the men failed to consider this source of water. Two groups commented that days after leaving a vehicle they thought they should have checked the radiator for water.

Past civilizations have found water in the desert, and many areas of North Africa are dotted with oases, wells, and cisterns. Only one survival story told of a man trying to find water by digging and then giving it up. He learned later that day how futile his attempt would have been when he met an Arab who led him to a well and then lowered a bucket an estimated 50 feet to reach water. Desert wells may be artesian and flowing in the established oases, or still water in open areas. Survivors who reached oases enjoyed their fill of water in the hottest parts of the desert. Other survivors found wells in which the water was scanty. Some survivors joyously discovered wells only to find them completely dry.

In addition to wells, many sections of the desert have cisterns. These are cavities or caverns dug into the ground by past civilizations for the purpose of collecting the occasional rain that falls in the area. It is likely that the numerous dry "wells" reported by survivors were actually cisterns. From the survivors' stories, cisterns appear in numbers along the north coast of Africa; and they are found frequently along wadis in the interior. One man even suggested that survivors head for the wadis and search carefully for holes in the banks in which water is collected. These cisterns may be well marked, have only a small pile of rocks

at the surface of the ground, or be unmarked except by trails leading to them. One cistern was so well hidden that a passing Arab pointed out the opening to it only a few yards from where the man stood. A party of survivors scanning the terrain with field glasses noticed a large can sitting in the open desert. They walked nearly a mile to investigate and found a cistern or well near the can.

The cisterns may be underground labyrinths and hold thousands of gallons of water. They may be deep or shallow. Survivors found some with stairs leading down to the water level, others with knotted ropes for descent, still others with only a rope attached to a cloth bucket (usually hidden under a rock nearby) as the only means of getting water. Several parties of survivors utilized the shroud lines of a parachute as a cord for lowering a container to the water level. Another group, without sufficient length of rope to reach the water level, lowered one member by his ankles until he was able to fill their containers.

The sides of the wells and cisterns may be solid stone or, if they are in loose rock or sandy areas, may be supported and strengthened in various ways. Survivors reported the walls to be lined with closely fitted rocks, well-plastered mortar, or roots of desert shrubs.

The rain water found in cisterns was usually sweet, although it was reported in some stories to be dirty or contaminated by animals or full of insects and algae. The wells possessed sweet water or water varying in saltiness from slightly salty to extremely brackish, according to the reports of the survivors. Shallow wells tended to be more salty than others, but one survivor who had used a well prior to his survival episode reported the water was much saltier during his summer visit than it was when he needed it in the spring of the following year.

One old-timer who served twice in Africa complained that in World War I the practice was to pump the wells or cisterns dry when an army was forced to retreat, but that in the current war the wells were either collapsed by explosives or were contaminated

by the addition of mineral oil or diesel fuel to render them useless.'

Reports from survivors in Ethiopia indicate that many of the wells in that area have water heavy in mineral salts, called magnesium or magnesia in the reports, and that this water acts like a good dose of Epsom salts. In Syria one survivor mentioned that the water was hardly potable because of the heavy sulphur odor and taste. Men who used extremely brackish water in emergency conditions indicated they suffered badly from the heavy salt content. Drying and cracking of the lips, less endurance, and exhaustion and collapse were all blamed on brackish water.

In the numerous stories of British, South African, and New Zealand survivors in East Africa, many reported dependence on surface water for drinking purposes. Men drank from water holes which they had stumbled on or had located by following animal trails. One group of survivors following an elephant trail were able to get sufficient water from the deep elephant tracks in the trail.

Most of these men related that the water holes were completely fouled by the animals that visited them. One man reported the water so fouled by urine that he could hardly stand the odor but his need was greater than his taste. Wells in the Red Sea area and on the Arabian peninsula were also reported fouled by camels.

Several men approaching the Qattara Depression encountered a torrential rain-storm and were able to refresh themselves in the pelting rain, wash, and fill all available containers in the sudden and unexpected shower. Another pilot reported he watched a wadi fill with water from a shower farther south and was able to get water from this unexpected source. These two accounts are the only ones reporting rain as a source of drinking water in the desert.

There were no comments on use, desire for, or lack of salt tablets in the stories studied.

b. Water Purification Methods

Most of the survivors realized they should

purify the water they obtained from the natives and the water they located themselves in wells or cisterns. In most cases purification proved impractical. The usual agents available today, halazone, globuline, or iodine, were not mentioned in the survival stories studied. Only seven accounts mentioned purification of water by boiling. One of these reports tells of a thirsty party which found a well of dirty water and, risking the consequences, drank their fill. Then they boiled 7 gallons of water to carry with them. Another group mentioned they carefully marked all their water supplies as boiled water and unboiled water.

c. Thirst Quenchers and Water Substitutes

At certain times of the year in North Africa the desert climatic conditions are such that dew forms. Four survivors reported they collected dew in the mornings from bushes, their equipment, or rocks. One man reported he arranged rocks to collect dew and managed to fill his canteen before he started walking.

Grass was chewed by two men in the survival accounts as a means of allaying thirst. Another party reported they chewed aloe berries for their moisture content. One group found snails, bit off the ends and sucked the juices to relieve their thirst. One party reported they had no water or food for 3 days and chewed desert scrub for moisture. Four men indicated they kept pebbles in their mouths to keep the saliva flowing. One of these said the stones did little good and that after swallowing some small stones he substituted a piece of string and kept one end dangling from his lips so he would not swallow it. Chewing gum to relieve thirst was also mentioned in the stories, however one of these men wished for plain gum and not the candy-coated type, which only made his mouth more sticky.

From the Arizona desert in southwestern United States there is one survival story of a Marine pilot who crash-landed in the flat desert. He had no canteen but he was able to find a barrel cactus. He was able to remove the top from this cactus and dig out

chunks of the pulp with the lid of a ration can he found in the desert. These he chewed to relieve his thirst. When he decided to move on he filled the pockets of his flying suit with pieces of the cactus pulp for future use. Similar stories are not expected from the African deserts. Cacti are not native there and only the *Opuntia* or flat-stemmed prickly pear type of cactus exists where introduced by men or escaped from former cultivation.

Survivors commented on the necessity of keeping the mouth shut and breathing through the nose to reduce water loss and prevent the drying of mucous membranes. They also warned against excessive conversation as a means of losing water and felt the less said in the desert trek the better. In order to accomplish this end one survivor recommended carrying a grass stem or straw in the mouth and breathing through this. He believed it prevented dryness and also gave him something to keep his mind on while walking. By shifting the position of the straw he was able to direct a flow of air to various parts of his mouth and he felt this relieved him.

The lips were the first portion of the mouth to dry out and crack and become painful. Many survivors were able to keep a layer of grease on their lips during the survival period. After 5 days of dessication some men reported the skin began to peel off their tongues and mucous membranes. One British party in British East Africa suffered greatly from a lack of water. Enduring thirst for 3 days the men in desperation moistened their lips with alcohol from their compasses. On the sixth day of their trek they found a water hole but reported by this time their lips were badly blistered and swollen.

None of the survival stories from this 1940 through 1943 period of the last war reported the men using urine to quench their thirst. It is well for the present day flier to keep in mind that alcohol in any form is to be considered as food and not as water; additional water is required to digest and excrete the alcohol. In an emergency situation where partial dehydration is to be expected, beer, wine, whiskey, or alcohol in any form is to be avoided.

3. Rest and Shelter

ONLY ONE GROUP in the survival stories studied reported they encountered a rainstorm. This group was delighted to have the torrential rain clear the air, supply them with drinking water and refresh their bodies. They had been walking for 14 days at the time and went on for 11 days more after the rain. Shelter from the elements in the desert involved protection from the sun and heat and the occasional sandstorm, not from rain.

Men surviving in the desert made the most of their location to find shelter and to obtain rest. By far the majority of men reported they slept in depressions they made in the ground and that they covered these depressions with parachutes, blankets, or tarpaulins. Men without such items of equipment resorted to covering their bodies with sand during the heat of the day for protection from the sun, to reduce water loss, or for the cooling effect of the deep

sand, and three men reported the pressure of the sand on their bodies gave valuable physical relief to tired muscles and allowed them to relax. Two men commented they were unable to sleep on the surface of the ground but that if they could bury their bodies they relaxed and did sleep.

Men in the rocky desert areas or those in areas of tufted grass hummocks, desert shrub, or thorn shrub often rigged shelters from parachutes using the vegetation to support these shelters.

One party of four, camped near a shallow desert well with an adequate supply of water, reported they soaked their shelter and themselves with water periodically to obtain relief from the heat by evaporation.

Numerous comments on the fly and sand fly situation indicated that rest without protection in the daytime was difficult in many parts of the desert. Apparently the insects were not troublesome at night. The

flies were described in glowing and profane terms and apparently were abundant and pesky, to put it mildly.

Survivors also made use of natural desert features for shade or shelter. One party in East Africa camped in the shade of a solitary tree for 2 days and continuously changed position with the movement of the shadow. Many found rock cairns already built and used the shade; others built cairns for shade. Desert tombs or Holy Men tombs were used by several survivors for the night's rest or for a daytime shelter. The tomb was all too suggestive, was one man's comment.

Survivors who found caves utilized them. Several men made the suggestion that the banks of wadis were particularly good places to look for erosion caverns which offered shelter. These apparently varied in size from small caves which would sleep two men lying side by side to majestic caverns which held parties of 10 and 14. Two men reported sleeping in hyenas' caves in East Africa, but both men commented on the stench in their accommodations. The wadi caves were used by the Bedouins with regularity, and the comment was made that in the heat of the day the best place to look for natives was in the wadi caves. Warning was expressed that caves used by Bedouin were generally infested with fleas, lice, and other vermin. One man found enough grass in one cave to offer a good rest but the bugs soon drove him out. He retaliated by burning all the straw he could find in the cave and then utilized the smoky but vermin-free cave for 3 days.

The most remarkable story of shelter was found in the report of a party near exhaustion which found a cistern containing a small amount of water in three bottom pools. A knotted rope enabled one of the party to descend and inspect the cistern, and his report of cool water promptly brought the remainder of the party into

the well. The men designated one of the pools as a bath and all enjoyed a refreshing swim. Another pool was reserved for drinking water. Once in the cistern the men discovered a ledge off to one side and they brought their luggage into the cave and prepared to camp there. Later in the evening the well became so cool one man climbed the rope to the surface to collect blankets and parachutes for warmth. On a later ascent he spotted a passing plane and the group was rescued.

A single story was found of a survivor who reached the north coast of Africa and slept on seaweed drift which he accumulated from the beach. He commented that it was rough and scratchy.

The change in temperature at night occasioned many remarks from the survivors. Those that traveled in the day and rested or slept at night reported that ground protection from the dampness was needed. A few indicated that the dew which collected on their apparel made them cold. The night air was described as penetratingly cold in January and February in North Africa, and many men were forced to wrap themselves in parachutes for warmth. Several parties reported they were forced to sleep together for mutual warmth.

A few men had sleeping bags available for their survival episode. One of these men commented that he had a colony of fleas in his sleeping bag after only a few days in the desert.

Sand invaded all types of shelter and sleeping accommodations, and in open areas the men were often forced to shake out their gear several times in the course of the night for comfort. Sandstorms also produced special problems of protection and shelter. Parachutes were generally pressed into use as head coverings and often a great many layers of cloth were required to keep the sand out.

4. Clothing and Wearing Apparel

ONLY A FEW COMMENTS on clothing were found in the survival stories studied, but a great many statements were made on the footgear worn or available to them.

Men who flew in regulation flight clothes experienced little difficulty on the desert with this apparel. One-piece flying suits offered the best protection against the desert

environment and were generally comfortable. Men who flew in sport shirts or thin bush shirts commented on the inadequacy of this protection against the sun, desert cold, insects, thorns, and rocks.

In general the clothing the men wore stood up well in the survival experience. No stories of improvising shirts or trousers were encountered. Clothing was generally worn; none was reported discarded, and, if anything, the feeling was that more clothing would be desirable.

Helmets were generally supplemented by the additional protection of parachute cloth. The men apparently adopted the Arab-type hats, which could be made easily from parachutes. A few men wore towels on their heads for protection and disguise. One man commented that a white linen head-dress was the best head covering for the desert.

Stockings and socks caused a few comments from the men who walked the desert. Woolen socks were indicated as preferable to cotton socks, and the short-topped civilian socks were roundly condemned by three men who wore them. The general effect was that these low socks kept sliding down into the shoes and made walking difficult. One man said that he would never again wear a pair of mended socks on a mission, at least those he darned himself. His rough repair work caused him considerable foot trouble.

Several men suggested that all desert clothing should either have elastic margins to the necklines, sleeves, trouser legs, and tops of socks and gloves or be equipped with drawstrings in these regions. They mentioned that the circulation of air was generally desirable but that many times the dust and sand combination made it preferable to tightly seal the openings.

On the subject of shoes the survivors who commented, and there were many, were unanimous in their opinion that GI shoes with high leather tops were the best. Civilian-type shoes, low-cut shoes, sandals, tennis shoes with cloth tops, and flying boots were all reported as causing trouble during the survival experience. The men wanted the ankle support of high shoes and

the ankle protection against boulders and thorns. Ankle support was specifically mentioned many times as essential in desert hiking. Type of footwear other than GI shoes came apart in the course of desert marches. The men were forced to repair their shoes by sewing, wiring or tying them together with strips of parachute cloth or shroud lines. The men noted that with each repair job the shoes became a little harder on the feet.

Sand and gravel getting into the shoes bothered many men. It was especially troublesome to one survivor who slashed his shoes with a jackknife for better ventilation. His comment was, "Never again."

Several survivors mentioned a heavy clamp-on crepe rubber sole used by the German forces as the best answer to desert travel. They felt that cushion rubber soles with cleats cut in the bottom would be ideal for desert walking and traction, but felt that the firmness of leather soles was also desirable. The clamp-on soles were needed in their opinion. One chap wanted to know if asbestos clamp-on soles were not practical to neutralize the heat of the desert terrain. Strips of parachute cloth were wrapped around shoes by survivors for traction and insulation.

A few survivors indicated they had taken off their shoes for certain periods. Several of these were forced to cross salt flats or marshy areas and decided to do it barefooted to save their shoes. Invariably a barefooted hike across a salt flat or mire resulted in alkali burns of the feet. A few indicated that they removed their shoes for comfort during rest stops and cautioned against this practice as their swollen feet went into the shoes with reluctance or not at all. A party of six was forced to walk barefooted because they could not get their swollen feet back into their shoes.

Off the coast of North Africa a pilot was forced to bail out into the Mediterranean. He took off his shoes while in the water to make his progress to shore with the aid of a Mae West a bit easier. Once on shore he walked 8 miles over the hot terrain to his base and was hospitalized for 5 weeks with burned and blistered feet.

5. The Health of Survivors

IN GENERAL the desert appears to be a healthy place, judging from the survivors' reports. Afflictions were relatively minor ones other than those caused directly by the sun or heat. Many men commented on their physical condition before the emergency as directly related to much of their success or many of their difficulties during the period of survival. Those in top physical shape with well-developed endurance and conditioned muscles were able to complete the long walk or survival experience better than those reporting themselves in poor shape.

Many of the pilots noted they had had nothing to eat prior to flying that fateful mission. Explanations were given to indicate that the nature of the food at their messes, specifically high in starch content in a few cases, was known by the pilots to cause gas at altitude. As a result these men never ate prior to flying a mission. The same men reported they wished they had had a meal before the long survival experience they then undertook. Two pilots commented that they had "tanked up" on cold water before the mission and that this led to difficulties of dizziness and cramps while in the air and also immediately after they reached the ground. A great many survivors mentioned that after their experience they would drink their fill before starting out on a mission just in case it ever happened again.

Enemy action accounted for the majority of the wounds and injuries the men received before reaching the ground. Interestingly, of the 10 accidents reported all injuries were to the feet or legs. Only 12 men were hurt in leaving the aircraft by bailing out. Six of these were cases of abrasions and six were cases of sprains. None of the accounts reported injuries in crash-landing, but 32 cases of injuries following parachute descent were found. These were sprains, abrasions, cuts, and one case of paralysis. One man who lost both his shoes and socks in the shock of his parachute opening reported his feet badly cut on landing in a flint-strewn desert area.

During the course of the desert survival

experience the sun and heat of the desert area caused the greatest difficulties. Sunburn and the effects of glare were the most severe hardships the men experienced. Sunburn on hands apparently was particularly painful to the survivors. Treatment of sunburn while en route consisted of using burn ointment found in the first-aid kits, and improvised treatment with cooking oil, poultices of juicy plants, and lubricating oil. Gloves or hand coverings were made from articles of clothing or parachutes specifically to prevent sunburn.

An individual tried to protect his body by smearing the exposed portions with "grease" from the bodies of snails he found in the North African desert. He concluded this was useless, actually caused greater condensation of sweat and added to the temperature, and increased the desire for water.

The heat of the desert sands caused painful burns or over-heating of the feet of many survivors. A few men reported they tried to counteract the heat by wrapping their shoes in several layers of parachute cloth. Blisters from wearing poor shoes were reported frequently. A great many men had much to say on the nature of the footwear best for desert marching. The consensus was that high-topped GI shoes were the best.

Blisters on the feet were treated as well as possible. Band-aids from the first-aid kits were frequently mentioned but always accompanied by the comment that the band-aids were too small or the adhesive sections too short or too dry.

Five men reported a condition of athlete's foot as it affected their travels in the desert. One of these men stated that a very slight case of athlete's foot spread so that not only his toes were cracked but the soles of his feet were split and extremely raw in a matter of a few days. All five agreed that a case of athlete's foot was one of the worst hazards they could imagine for desert survival. All five felt that a change of socks would have helped but that none were available.

The effects of dust or blowing sand were indicated by a great many men. One com-

mented, "Don't remove your sunglasses for even 1 minute in the desert," and referred to the trouble he had had getting particles of sand from his very dry eyes. Medical reports on many of the survivors indicated a mild to serious sinusitis following the desert experience, probably due to irritation by the dust particles. The men commonly used filters of cotton, grass, and other materials in the nostrils to keep the sand out and found them worthwhile. Men complained continuously of sore eyes due to the glare and the abrasion of dust particles on the eyelids and eyeballs. The report that eyelids felt like emery paper indicates the degree of discomfort that can result from dust.

Skin irritations from the blowing sand were minor, although a few reports of skin dermatitis from sand in the beard were found. However, skin abrasions from falls and bumping into rocks caused considerable comment. Skin abrasions in the desert seem to result in desert sores; these troubled a majority of the survivors. Desert sores were painful and very slow in healing. Sores were reported to last days and even weeks. The survivors acknowledged that fair-skinned men not only burned more easily than darker-skinned men but also developed desert sores more readily. Generally the desert sores contained pus and the large scabs which formed over these sores were difficult to retain in place. Attempts were made by survivors to cover their wounds with bandages or improvised bandages of clothing or parachute cloth, but without ointment the bandages stuck and caused further discomfort.

The attraction of flies to the open wounds disturbed the survivors greatly. All felt the flies, everywhere abundant, were sources of the infections which followed. The men chased the flies to the point of distraction, and then inevitably ignored the flies and took the consequences.

One man reported abrasions from the heavy salt concentration in his clothing. He attempted to shake the salt out periodically by heavy kneading or beating the garments against rocks.

Sand flies were troublesome in certain

areas. Men without the protection of fine mesh nets or repellents resorted to wrapping themselves in parachute cloth, alternately giving in to the heat and to the attacks of these flies. Three cases of nausea, vomiting, and muscular ache were found in the survivors' stories. The symptoms usually passed after several days of rest. It is possible these symptoms indicated sand fly fever.

Collapse in the desert may be attributed to effects of the heat or to simple physical exhaustion. One survivor reported using an ammonia inhaler to treat other members of his party. Another reported that applications of a bottle of shave lotion he had along were the best treatment. The heat caused dizziness in many of the survivors and all men who reported such symptoms also reported they rested for a few hours to several days following such attacks. A general complaint was the inability to sleep because of exhaustion.

Intestinal and urinary troubles were experienced by a few survivors. These were attributed to food and water, or the lack of it, and also to sleeping on the ground. Men who were fed by wandering tribes after several days without food and water reported severe attacks of indigestion from dates, rice fried in oil, and especially from the Arab bread. Only three cases of desert dysentery were found in the stories studied, but all of these reported the dysentery to be extremely painful and accompanied by a high fever necessitating a rest for a few days. Four men reported that the cold nights and the lack of proper ground sheets resulted in chills and stomach cramps.

The lack of water for extended periods of time had definite effects on the health of the survivors. Both shrinking and swelling of mucous membranes of the mouth were reported. One man reported his tongue was so large he felt he couldn't keep it in his mouth. Several men commented their mucous membranes began to peel, and enough accounts were available to conclude that 5 days of dessication, on the average, would bring on this condition. Cracked lips and tongues were reported frequently and indicated as extremely painful.

Difficult and painful urination was a common complaint of survivors after 3 to 4 days of desert survival. A few men commented they had had no bowel movements during the period of survival. In one case this was 21 days with a minimum amount of food and water.

Survivors from Morocco, Tunisia, and British East Africa reported infections from spines and other plant parts. These were apparently cactus spines in the first two locations, and spines from acacias and similar trees in the East African area.

The inability to wash clothing and bodies

and to brush teeth was noted in the survival reports. Generally the men objected to the smell of their own bodies and of their companions, but recognized that nothing could be done about it. All felt that a change of clothing, especially socks, would have made their trek a bit easier. If the men did find sufficient water, they all took baths or enjoyed swims in oases, streams, or cisterns. This was more for physical relief from the heat than for cleanliness, although one hardy soul suggested that hard-water soap be added to the emergency equipment to be carried in the desert.

6. Food and Hunger

a. Rations

With a shortage of water the immediate problem before most of the desert evadees, the food supply or shortage of food seemed inconsequential. If the men had rations they ate them, or tried to, depending on the amount of water available. Men short on water had little desire for food although one man reported his hunger pains did not bother him after the fifth day. Thoughts of food entered the minds of only a few survivors. Few attempts were made to ration the supplies of food available, according to the stories studied. Generally desire dictated the use or rejection of food. Men supplied food by the natives after a period of near starvation generally suffered from cramps, severe indigestion, or an uncomfortable feeling. After such experiences the men preferred to do without food until they were sure of its purity.

The rations carried by the survivors varied considerably with the period of operation and the types of planes flown. In the early period of these survival stories, 1940 into 1942, British rations were mentioned most frequently. In the episodes which occurred in late 1942 and 1943 American rations, particularly D and K rations, were mentioned.

Tins of bully beef, biscuits, corn, tomatoes, iron rations, concentrated food tablets, vitamin pills, Horlick's milk tablets, condensed milk, tea, dates, sugar, caramels,

hard candy, toffee, and gum were mentioned, in that order of frequency, as the rations carried.

In 1942 and 1943 most of the survival stories dealt with American fliers and here the rations carried became D and K rations, with Horlick's milk tablets, hard candy, Charms, and gum following in that frequency.

The D ration, a concentrated chocolate bar, was thoroughly despised as a survival ration in the desert. The hard candies were mentioned favorably in some stories; a mint flavor and acid-lemon or acid-lime flavor were indicated where preference or specific comment was made. Horlick's malted milk tablets were desired in larger numbers by a few men. The comments on the caramels were that these candies were disagreeable under desert conditions and generally increased thirst.

Such rations as the men did have were generally eaten cold or uncooked and the foraged materials were eaten raw or uncooked in all but a few instances. A very few men indicated they were able to roast or half-roast some of their food. One man traveling along the north coast of Africa reported he boiled his food in sea water.

Men smoked very little if at all during desert survival episodes. Smoking tended to dry out the mouth according to some reports, but the majority of the men who commented on smoking mentioned they were

just too dry and that cigarettes did not even seem desirable.

A good story of the use of rations in the course of desert survival involves a member of the Long Range Desert Patrol who was isolated in the desert. He found an old opened can of condensed milk in a former camping spot. Small bits of curled dried milk clung to the sides of the can. Nearby were the sun dried tea leaves previously discarded from a pot of tea. The survivor in his desperation for a spot of tea added the old tea leaves and water to the milk can and brewed some "terrible" tea. This same survivor planned to walk to the Sarra oasis in hopes of rescue or at least of finding some water. As he walked in that direction he recalled that on an earlier stop at the oasis he had discarded some lentils from his mess kit. He remembered the exact rock where the lentils were dumped. When he reached the oasis the well had been destroyed and no water was available, but behind the rock were the lentils which had preyed on his mind. He recovered the lentils but concluded they were too hard and dry to be eaten.

b. Plant Materials as Emergency Foods

PLANT materials did not enter into the survival picture as important sources of emergency foods in desert areas. In general the men apparently did not see plants which they considered worth trying or else the comments indicate that the vegetation was so burned up in the heat as to be unusable.

Survivors chewed grasses in the full extent of the range of desert episodes. Alfa grass in Tunisia was mentioned in half a dozen stories where the men pulled the stalks and chewed on the soft bases. In Libya men sucked on grasses for what little moisture and food value they could find. In the Sinai Desert one man commented that the grass was abundant but the animals had beaten him to all the succulent parts. A party in British East Africa found all the grass burnt up and not even one blade was green enough to eat. Several men in Ethiopia reported that for days they

sucked grass, chewed grass, boiled grass for dinner and supper, and even argued over which grass had the most flavor when eaten raw and when cooked.

A party in the Western Desert of Egypt found aloe berries in quantity and ate these for both moisture and food. A comment was made that the partially ripe berries were better than the fully mature ones. Aloe is the source of a well-known bitter medicine. It is possible that the bitter principle is not present in the berries of this plant but in general aloes are not recommended as a palatable item of food.

In southern Libya one group tried to eat the wild melons found growing on the desert. They found the leaves and the fruits to be extremely bitter but the seeds, particularly those of very old and desiccated melons, to be as palatable as sunflower seeds.

In the deserts of East Africa, Kenya, and Somaliland men ate roots which, they commented, always grew vertically in the ground and which were hard to dig from the dry soil. A party in East Africa in desperation decided to try eating some of the berries they saw but they made it a suicide pact. Each man was to eat the berries at the same time so that if they were poisonous the entire party would die. They lived.

The pods of the acacias were tried by a group of survivors in Ethiopia but no further comment was made on the edibility of these fruits. The young pods of these trees may be palatable depending on the species and some of the older pods may possess gums which are reasonably edible.

Dates were supplied to many survivors by Arabs and Bedouin. Only one survival story reports that a man found a small uninhabited oasis consisting of some grass and three date palms. He ate the green dates with relish.

c. Animals as Emergency Foods

Most of the survivor stories contain some reference to animal life seen or shot, caught and utilized for food. More men and parties used gazelles for food than any other animal. The gazelles were wary and hard to stalk; invariably it was a running and gen-

erally lucky shot that enabled the party to obtain these animals. A party of three ate well for 6 days on gazelle meat, which they reported always abundant. The gazelles caught ranged in size from scarcely larger than a rabbit to animals of 75 to 100 pounds. The gazelles were eaten raw and the meat was described as juicy or dry, tasty or obnoxious, stringy or tender. Relatives of the gazelle, the dik-dik of East Africa and the gazelline antelope or gerenuk, were shot by parties in Ethiopia and Kenya. A kid goat was reported in one survival story as wandering around the desert "yelling its head off." The survivor had raw kid for supper that night and reported it good.

A thub, a large spiny-tailed lizard of the Arabian Peninsula, was used as emergency food by a group of three men. A large gray lizard and plain "lizards" figured in the menus of six other stories from North Africa. The lizards were hunted by one party in holes in the ground, under rocks, and in crevices in the rocks. A survivor in Arizona caught lizards on the branches of trees. He killed and skinned them with his sharpened belt buckle and ate them raw. All lizards were reported to be fast-traveling animals and required agility to catch.

Birds of various kinds were hunted and when caught used for food. The "habara," a bustard the size of a small turkey with a peculiar habit of running, then flying a short distance, and then running again, proved to be excellent eating for several parties. Six additional stories reported hunting bustards but with unmentioned success. A party in Ethiopia shot a crow and a small hawk which were "half roasted" and used for food. A party in British East Africa made an attempt to catch birds using a birdlime. The birdlime was prepared by chewing the sticky succulents of the area. While these men showed ingenuity in their attempt to obtain food material, the practice was a dangerous one for partially dehydrated men in a desert. The succulents of Africa, which have a sticky principle and so would make satisfactory birdlime, have a milky juice. They belong to families of plants which are generally bitter, astrin-

gent, or poisonous. One of the first rules of survival dealing with plant materials is to avoid unfamiliar plants with milky juices; this should apply to chewing them for birdlime as well as using them for food.

Chickens were bought from parties of Arabs by some men and several stories mentioned eating the chickens raw. One man expressed amazement at seeing a chicken loose in the desert. He commented that the Arabs usually keep the chickens inside their houses and he wondered how this one managed to escape unnoticed. By stalking it carefully he was able to catch the bird and after killing it he "devoured" it raw.

Chickens' eggs were procured from passing natives according to some survival stories, and one party found an owl's nest and ate the eggs therein. They commented that the eggs contained half-developed embryos.

"Kangaroo mice" were reported as food material in two stories. One other account told of catching brown mice in the desert, and gray rats in old dugouts, and using both for food. Land tortoises were eaten by survivors in East Africa. One survivor found it difficult to crush the shells; he was forced to drink the blood and eat only what muscles he could pull from the shell of one tough animal.

Insects served as food in six stories. One man had no trouble catching beetles; he reported taking off the hard parts and eating the softer bodies. Grasshoppers and locusts were used after the wings and hind legs were removed. Another survivor reported his diet included large flies which he ate by holding on to the wings.

Desert animals which were seen by survivors but not mentioned as being eaten included: ostriches, foxes, grouse, hyenas, jackals, bats, solpuggids, and prairie dogs.

Survivors who reached the coast used a variety of sea food. Peri-winkles, sea urchins, oysters, crabs, and fish were collected and eaten. The fish were generally found stranded on the beach in a partially dried condition or impounded in tidal pools where they were easy to catch.

One group of survivors heading for the Mediterranean coast of the Western Desert

were desperate for both food and water. They noticed that one stretch of rocky desert appeared to be paved with small land snails. One adventurous member of the party started biting the soft point of the shell and sucking out the juices. Another member of the party tried it and reported the odor and taste caused him to become nauseated. However a short while later he too was hunting out the snails and sucking the juices and eating the meats. Eventually the men registered the complaint that the birds were beating them to the snails and that all the shells were empty. However, by diligent searching they were able to locate enough full shells to keep them in fair condition until they reached the coastal road and were rescued.

d. Food Supplied by the Natives

WANDERING tribes of native Arabs, Bedouin, and Jews, were reported in some survival stories. These tribes supplied various survivors with food materials, meals, or kept them for periods of 1 to 30 days.

The survivors were usually able to get chickens and eggs, which they knew and trusted as items of food. Other food mate-

rials mentioned as purchased or supplied during the course of survival episodes were: camel's milk and goat's milk, bread, butter floating in honey, rice, roasted truffles, coffee, dates, and goat meat. The men found the bread unpalatable as it usually caused severe indigestion and cramps. The camel's milk was occasionally mentioned as diluted with water. Two men reported the rice served had been cooked in rancid oil or rancid butter and this was either refused or eaten with subsequent troublesome digestive effects.

Dates were served ripe or immature. It was mentioned in one survival story that about 10 percent of the ripe dates contained large fat juicy worms which tasted exactly like the date. He added that if you forgot about the worm all went well, but it was hard to keep from looking for the insect.

One pilot spent a month wandering about the desert aided by Bedouin. Finally the tribe gave him a she-camel and showed him how to milk her. With proper directions for travel he started off to his own lines riding the camel and living off her milk. Both the camel and the lieutenant were rescued.

PART III

HAZARDS OF SURVIVAL

1. Animal Dangers

SURVIVORS IN DESERT AREAS found little in the way of large wild life to bother them. It proved to be the flies, sand flies, mosquitoes, ticks, lice, and fleas which were most irritating and annoying.

Large dangerous animals were reported in a very few accounts. Men in Kenya and British East Africa saw lions and one group reported they bumped into a herd of elephants which took no notice of them. Lions prowling in the night were scared away by a Very pistol discharged by two British fliers. The men who slept in hyenas' cave in Kenya wondered what would happen if the animals returned.

The only man who suffered injuries from large animals are reported in three individual accounts from North Africa. One man, approaching a herd of camels, was kicked by an animal. Another man reported he was bitten on the top of the head by a camel while talking to the rider. The third survivor commented on the vicious, starved Libyan dogs and reported that one "nipped" him and then trailed him for miles across the open desert. He had no food and was afraid the animal meant further personal attack.

Most of the survivors' stories contained some mention of the flies. These are reported to be extremely abundant even in remote areas of the desert. Comments were made that the flies descended from nowhere and that rest or sleep in the middle of the day was impossible because of these swarms of flies. One man reported he was not bothered by flies until the day he slipped and scratched his arm; almost immediately flies appeared and, try as he would, he could not keep them from his minor wounds.

Sand flies were even more troublesome in that they are small, can crawl through the finest nets, and bite painfully. Three cases

reported were diagnosed as sand fly fever resulting from desert experiences with these small insects. However, the worst effect on most men encountering sand flies was the constant scratching resulting from the bites of these insects. Apparently repellents were not in the emergency gear issued or carried at this period, for no mention is made of it in the stories studied. Several men tried various means of getting relief from the sand flies. The most common method was to chew up a cigarette and then smear the juice on the body. This method was also suggested as useful in killing body lice.

Mosquitoes were locally abundant in the desert areas, especially near the coastal areas and around inland marshes. Mosquitoes generally appeared in numbers at dusk. One man reported them to be so bad that he was forced to get into his sleeping bag for protection; however, by 8 p.m. the mosquitoes had disappeared and he was able to continue walking unmolested.

Fleas and lice were picked up in Arab and Bedouin quarters; many men noted their abundance in caves formerly used for shelter by the nomads. Any building was sure to be swarming with biting insects in the desert and survivors gave specific warning against sleeping in such quarters.

A single episode of trouble with ticks was reported. One story mentioned that a small snake had crawled into the man's sleeping bag. Three men reported they had been bitten by scorpions. Two of them reported the animal to be a small yellow scorpion which is almost harmless; the third man described a large black scorpion which can be deadly. In Kenya Colony several men reported that caterpillars dropped from the trees and left large painful weals if they landed on exposed flesh.

2. Dangers from Plant Materials

A FEW SURVIVORS mentioned their difficulties with spiny desert shrubs. The spines of some of the acacias caused trouble in East Africa; these could be easily removed from the flesh. By contrast, cactus spines have retrorse barbs; the men who reported injuries from these plants commented on the difficulty with which the spines were removed and the frequency of infection in such wounds.

Also mentioned in the survival reports of spiny or dangerous plants was the thistle, probably *Eryngium*. One man in the Egyptian desert said this plant was so thick that it was impossible to walk or sit down without being pricked by the spiny leaves and flowers.

Plants causing dermatitis were not mentioned in the survival stories and no difficulties were expressed in the stories of the few men who ate plant materials.

PART IV

AIDS TO SURVIVAL

1. Contact with the Natives

THE WANDERING TRIBES of the North African deserts apparently befriended Axis and Allied survivors alike and without prejudice. One British pilot reported his host had had a German as a house guest the day before his arrival. Generally the treatment by Arabs and Bedouin was as courteous and generous as the situation allowed. We know, of course, only the stories of those men who came back to report.

Identification cards or chits were mentioned in 17 of the stories examined. In all of these the survivors stated that at least one man in a caravan was able to read the card and so accept the responsibility for the survivor. One man mentioned that after long and fruitless conversation with an Arab in the middle of nowhere the Arab finally mentioned one word he could understand, "New York." Although he was from St. Louis, he promptly accepted the identification with the larger city and was cared for by the tribe.

The duration of nomad hospitality was generally short. Men were supplied a drink of water or milk, given a little food or a meal, and the contact was broken with the tribe proceeding on its way. A few men were boarded for periods of several days. One pilot spent a month with a tribe of Bedouin.

Cloth to make a hat was supplied to one survivor for protection against the sun. Another was given a long flowing robe for disguise. Four men reported the tribesmen helped them repair their shoes so they could

continue walking. The Arabs treated one survivor who had been suffering from numerous flea bites with a concoction of salt, vinegar, and honey.

Payment for services rendered was mentioned by only three men. One stated that his host wished a section of his parachute and he gave him just that. Another reported he paid for food with coins from his escape kit and that the tribe debated whether to accept United States money. He wished for some other unit of money, preferably gold coins. The third man gave his host a pen-knife in payment for services rendered. A party of Senussi in North Africa cared for a group of three men for 6 days and then refused payment of any kind.

Two cases of theft were reported among the survival stories. One Arab volunteered to go for help and stated he would send a rescue party to the well where the men were staying. After his departure it was noted that a blanket and a sleeping bag were missing. Two days later a search party did arrive saying they had been sent by a native Arab who did not reappear. The other party reporting a theft suffered the serious loss of a web belt with attached knife and canteen.

In the stories from East Africa all of the natives proved hospitable to the British troops involved in the stories. One chap reported it was difficult, for a time, to make the Ethiopians understand he was British because of his dark skin and hair.

2. Emergency Signaling and Equipment

AN UNEXPECTED ANOMALOUS SITUATION was revealed in a study of the methods of signaling used by survivors. Various factors contributed to a situation which reveals that signaling methods used in desert areas in 1940 through 1942 were ineffective. These factors are worth considering: 1. Most of

the men traveled at night and slept in the daytime. 2. Military operations of aircraft during this same period were conducted primarily during the daylight hours. 3. No effective rescue organization or search procedure was established during the period. 4. Identification of ground parties at night

was extremely difficult and the few night signals seen by pilots were generally ignored. 5. Without proper cover and concealment and with little chance for hasty escape, men on the ground were forced to be certain of the identification of passing aircraft before attempting contact. 6. The ground haze during the heat of the day made visibility difficult for the men on the ground as well as observers in aircraft. 7. Efficient signaling equipment was not generally available.

A variety of stories contained these observations. Probably a majority of the desert survivors traveled at night during at least part of their emergency experience. The men did this for the obvious reasons of comfort from the heat of the day, and the ease of night navigation by the stars in contrast to the common lack of landmarks for daytime travel. They likewise slept or sought protection and cover during the heat of the day. Only a few men indicated in their stories that they marked their location during their hours of daylight rest. These men spread their parachutes or marked large letters to indicate their position. Thus passing aircraft were seldom given distress signals by the evading parties during their sleeping hours.

At the same time the war was conducted primarily during the daylight hours. Night bombing techniques had not been perfected. Landing fields were not equipped to handle night missions and only scattered patrols were conducted, generally by soldiers on foot, during the night. While the survivors were traveling, relatively few other military personnel were operating, and the chances of rescue or recognition were small.

Air-ground contact was poor during the early phases of desert operations. Several survivors who were equipped with Very pistols or flares indicated that passing aircraft ignored their signals or if they did circle the area the men were usually unable to make satisfactory contact. There were no reports in the survival stories of the use of radio contact with their bases or with passing aircraft. Emergency radios such as the Gibson Girl were not mentioned. The men

on the ground found themselves in the position of being unable to identify themselves at night to passing aircraft.

Identification during the daylight hours was almost as difficult. Since the men were out in the open, with little opportunity for cover or hasty concealment and escape, the ground parties hesitated to signal passing vehicles or planes unless they were relatively sure of identification or unless they were desperate and ready to surrender if necessary. This meant that the vehicle or aircraft had to approach close enough to be identified before the evadees would reveal their position and attempt contact. In the case of passing aircraft this meant a minimum amount of time was available to the ground party to attract attention. Several parties reported that yelling, waving shirts, spreading parachutes, building fires, or discharging flares at the last minute failed to attract attention of identified Allied aircraft.

Desert haze coupled with the effects of mirages further complicated the problem of daytime signaling. Desert haze was a layer of warm air close to the ground which distorted vision and limited visibility to 400 yards in most cases reported. Evadees experienced difficulty in locating passing aircraft through this haze. In many of the cases of desert haze mentioned the men were able to hear the aircraft long before they were able to see it. Even when they did locate the aircraft or passing vehicle, identification was handicapped because of the distortion or swimming appearance of the object. One survivor commented that the aircraft appeared as though through cheap and wavy glass, and he was never sure of what he saw. Another reported it was easier to identify the aircraft by sound than by sight through the haze. Still another party commented that the haze so distorted their vision that they were never sure of the exact location of the aircraft and that various members of the party placed the object sighted with discrepancies of 30 degrees. How to use a signal mirror under these conditions, if one was available, became a real problem.

The problem of sighting ground parties

from the air was equally difficult. Several reports were studied in which the crews of the aircraft reported they could not be sure of small objects on the ground because of the distortion of vision in the haze.

A much needed study of emergency signaling methods in desert areas is indicated by the experiences of these survivors.

Emergency signaling equipment was not generally available to the survivors in the episodes under consideration. Signal mirrors were used in six survival stories and in all without success. Various men tried outlining large letters of identification in the terrain, and one of these, a large USA, was reported effective. Another signal, large letters of SOS with an arrow indicating the direction of travel, led to the rescue of a party 2 days later. Fires were tried in several dozen cases but nearly all survivors mentioned one difficulty or another with fire signals. Generally these were lack of fuel, inability to build more than one fire, inability to build a large smoky fire, and the lack of matches or other means of starting a fire. Fuel was a problem in many desert areas and survivors warned of igniting fires before they were really needed. One suggested that fuel should be carried with men traveling on foot since it was not always available and was usually most difficult to find when it was most needed. Ten stories were read in which the men had no fire-making equipment at all. These men did not even carry matches with them prior to their emergency descent. One pilot reported he tried to make a signaling fire by focusing the sun's rays with his flying goggles. When this failed he tried striking stones together to get a spark. With no luck here he tried the "bow and socket" method with a continued lack of success. One flier who had no matches reported he was so mad at his situation "he was hot enough to burn himself."

Men who did build fires suggested the conventional signal of three fires in a line

would be most effective. Another reported that his squadron had adopted the practice, after his rescue, that the desert area would be monitored for signal fires between 8 and 10 p.m. each evening as that would be the most effective time for signaling.

The emergency radio, the use of signal panels other than parachutes, and colored smoke grenades were not mentioned in the survival stories available. However, the age-old emergency signal of three rifle shots proved effective in the rescue of parties in Ethiopia, Tunisia, and the Sinai desert area.

A practical suggestion worthy of consideration came from one of the survivors interviewed personally. He felt that all desert rescue gear should include cans of colored powder which the survivors could spread on the desert floor. He compared this to the use of seamarker dye on the ocean and suggested either an iridescent pink-red powder or perhaps a combination of this with a phosphorescent powder for retention of light and night signaling.

Several survivors mentioned with disgust the futility of voice signals in the desert. They suggested whistles for desert survival. A whistle in which the tone could be varied was felt to be most effective over the noise of the winds in the desert areas. Various men mentioned that trucks passed within yards of the men and that they were unable to attract their attention by yelling. A Taylor Cub which landed near a survivor in Arizona could not be hailed by the survivor and took off a few yards in front of the desperate man. Voices might carry with the wind in the desert but certainly were ineffective against the wind or for even short distances cross-wind.

The conclusion can be drawn from these stories that emergency signaling presents special problems in desert terrain and environments. Special attention must be given to signaling methods and identification methods during dusk and dawn, daylight and night hours.

3. Rescue Activities

RESCUE ACTIVITIES call for cooperation on the part of both the survivor and the rescuer. There are many examples of a lack of

this cooperation in the survival stories for desert areas during the 1940 through 1943 period. Perhaps the most serious of these

was the failure of the survivor to stay in place once he was located. Many stories tell of the party on the ground being located by passing aircraft and having supplies dropped to them. With these meager additional supplies the ground parties moved on, generally without instructions from the aircraft. This led to additional search time on the part of the plane, often involving 3 to 4 additional days before rescue could be completed. Seven stories are available from survivors indicating that even after the men had been located by air a few members of the party decided to continue walking and were never heard of again. In three cases in southern Libya, reported in official documents, the entire parties on the ground were located and materials dropped to them but the men had moved by the following day and were never located again. One story told by a survivor reported that the party was seen by a passing aircraft which spotted their parachutes spread out on the ground. The men accepted the food and water dropped and then rolled up their parachutes and awaited rescue. It did not occur to them later in the day that the planes circling in the distance were looking for them and it was several hours before they recovered their senses and spread their parachutes again.

Survivors were rescued in a great many ways. Caravans aided many parties. Desert patrols found some. The Long Range Desert Patrol of the British Forces was particularly effective in locating survivors. Some men were picked up by small aircraft which landed specifically for the task. Perhaps the most extensive rescue operation involved a crew of a B-24 down in the black rock area, "the Coal," of southern Libya. These men were located after 2 days and were found in two parties of four men located 8 miles apart. Supplies were dropped to the men and rescue organizations were formed. The men, however, could not be relocated by air at the former positions taken, and 3 days passed before they were relocated and resupplied. Another 5 days passed during which time a large rescue party started to them by truck. The route the ground party had to take involved

crossing extensive areas of soft sand and then traversing the boulder-strewn "Coal" in which the men were downed. The problem of supplies of gasoline and water for the rescuers was a major one and the rough terrain caused the trucks to break down repeatedly. By the time the men were located by the ground party some of the survivors had started off on foot. An attempt to follow them proved futile. Their rolled-up parachutes were located under some trees a few miles farther, but the men were never found. Four of an original party of eight men were lost even after they had been located by air and notified ground rescue teams were on their way. The remaining four survivors were taken to an improvised landing strip and flown out. Total flying time involved in this rescue was 120 hours. The land parties covered 1,350 miles in the process of rescue, but due to the foolishness of the survivors the rescue was only 50 percent effective. Four of the men literally lost themselves in the vastness of the area.

The problem of signaling in desert terrain comes up again in relation to rescue by ground parties. Survivors in the open expanses of the desert apparently are as hard to find as men concealed in the thorn brush. Desert haze limits the daytime visibility of survivors and rescuers alike. Mirages work both ways and stories of men, caravans, and rescue parties appearing out of mirages indicate that special attention should be given to these problems of establishing contact. Sound signals proved most effective to ground rescue parties in the daytime in desert terrain. Men were located in four cases by the repeated firing of rifles.

Brush fires set by survivors in Kenya and Ethiopia proved effective in directing rescue parties in the shrub-land desert of East Africa. One party in British East Africa was completely exhausted after 15 days of short water and food rations. They lay under a tree and watched the vultures circling overhead. It was those same vultures that led the ground rescue party to their location.

Survivors also had a lot to say on the subject of equipment dropped to them and the methods in which it was dropped. Generally

their most urgently needed item was water. Survivors' comments were bitter on the subject of water bottles, canteens, or cans of water which broke when dropped to them. There are numerous stories in which every container of water broke on the fall. The survivors felt that some special container should be devised to drop water without putting the survivor through the agony of seeing much needed water trickle through broken containers into the ground. Present-day rescue gear is adequately packed, brightly colored, and generally dropped by parachute. In the period in which these survival episodes took place practically all equipment was improvised.

Dropping gear should also be well marked.

Numerous items of equipment dropped by rescue aircraft could not be located in the desert terrain. The improvised emergency gear of the period lacked streamers or parachutes and was not brightly colored for clear visibility. One party reported they found only one of nine packages dropped to them in the open desert of Libya in spite of extensive searching for 2 days. The one package they did locate contained dry bread. The difficulty of finding small objects in the desert is well indicated in the tale of the Arizona survivor who could not relocate his parachute when he walked an estimated 500 yards from the spot where he had spread it out.

4. Survivors' Comments on Equipment

MANY OF THE SURVIVORS' comments on equipment have already been mentioned in other sections of this study. Unfortunately all comments found in the survival episodes represented afterthoughts and indicated that little planning for emergencies had occurred prior to the fateful flight, and that little briefing had been given on rescue procedures or survival activities. Some prior thought and preparation would have made for easier survival periods.

Men who survived and whose stories were studied wanted knives, maps, compasses, matches, first-aid kits, insect repellent, sunglasses, hats, proper shoes, extra shoelaces, needles and thread, and gloves. All of these

are items a man should be carrying on his person or have at hand as emergency equipment in his aircraft. A few additional materials mentioned do not fall into this category. Individual survivors wanted hard-water soap, a tooth brush, dental floss, reading material, package tobacco instead of ready-made cigarettes, DDT powder for lice, a razor, a sextant, and puzzles.

One survivor who was carrying an aluminum canteen wanted some sort of plastic guard for the mouth of the canteen and suggested a small plastic lip for the narrow edge of the canteen cup. His experience was that the canteen and canteen cup often became too hot to touch with his lips.

5. Survival Training

SURVIVAL TRAINING OR BRIEFING on survival was woefully inadequate or completely lacking in the cases studied. This is indicated in the words of the survivors themselves and the reports of their episodes. The men were not briefed on what to do. Their decisions were their own. It is no wonder that in the face of obstacles of the desert so many of them surrendered. The stories indicate the only emergency gear available to the men at the time was the escape kit. Two men stated that they had no idea what was in the escape kit until they were forced to use it in an actual emergency, and then they

found the kits inadequate. The men flew in whatever clothing they chose and carried with them whatever gear they wanted to accumulate and place in their aircraft. One survivor who bailed out reported there was no sense in walking to the site of his burning plane for he knew there was nothing in it he could use.

The men who had anything to say in their reports on this lack of training and equipment were bitterly pointed on the situation. Many of them felt that someone could tell them what to do. One man commented, "I know the Germans have books

telling them how to live in the desert, so why don't we?"

The many survival manuals, articles, and instructions written in the following years indicate that the need for such information

and training was felt and something was done about it. Rescue procedures, organizations, and survival training developed since 1943 should not permit a repetition of the inadequacies evident in these stories.

6. Philosophy of the Survivors

TWO ALTERNATIVES seemed available to the survivor in the deserts of North Africa during the war. One was to surrender to the nearest forces and the other to exist as best he could under the conditions and possibly to walk out. The number who did walk out indicates the courage of this group of desert fliers.

One man who chose the desert rather than the nearby Axis lines and walked 200 miles in 26 days commented, "I knew the

war was just starting and that it would be a long one. I preferred to take my chances in the fighting, perhaps to make a contribution to it, rather than sit the damned thing out in some Axis prison camp."

The general feeling expressed by the men was that their survival depended on their ability to adapt themselves to the existing conditions. This called for mental as well as physical adaptation. Many of them were successful.



CONCLUSIONS AND SUMMARY

THIS STUDY of desert survival episodes is not intended to be a statistical study of experiences or chances of survival. It is intended instead to present the nature and range of the experiences of military personnel isolated in desert areas during wartime.

The conditions under which these survival episodes occurred were hazardous. The men had been poorly prepared for the emergency mentally and physically. The episodes took place during a period of World War II when briefing on emergency procedures was inadequate, survival training non-existent, rescue organizations and search procedures unorganized, and survival or rescue equipment improvised. Most of the men flew with the knowledge that no one would look for them, unless it was a member of their own squadron, and that they were supposed to get back as best they could, alone and unaided. However, the flux of activity in the North African desert at least made the act of survival easier through strictly abnormal desert conditions of abundance of vehicles and personnel in the desert area.

1. Reasons for the emergency: Desert emergencies occurred primarily because of enemy action. Faulty navigation and lack of fuel ranked second. Mechanical failure was the third primary cause of the emergency.

2. Nature of the descent: Parachute landings following bail-out and crash landings occurred with about equal frequency in the stories available. Most survivors concluded, however, that if conditions were favorable a crash landing was preferable because of the source of materials in the aircraft.

3. Actions following the landing: In all the stories studied the survivors walked back to their own lines or walked to enemy lines and surrendered. Since no hope was held out to them of search and rescue by friendly units, the men usually destroyed their aircraft and classified materials and then proceeded on foot. This is prescribed action in enemy territory. In friendly or neutral

territory men should stay near the site of their emergency landing in all but the most unusual circumstances; today, developed search and rescue procedures should bring a speedy ending to such emergency survival episodes.

4. Duration of the survival episode: This study is based on successful survival in 382 individual episodes. These stories also revealed that 142 men, at one time associated with the survivors, were lost, strayed, or died in the process of the survival episode. The episodes took place in 1940 through 1943 and occurred primarily in North and East Africa. The men who survived were out 1 to 29 days and traveled 10 to 350 miles across desert terrain. If figures are significant, they reveal that the average survivor was out for 5 days and covered an average of 50 miles in the course of his survival episode.

5. Hazards of the environment: The heat and the effects of the sun coupled with a shortage or complete lack of water proved to be the most dangerous factor of the environment for most survivors. The physical discomfort from the heat of the day and the heat of the terrain troubled the men. The cold nights were mentioned in many stories. The brightness of the sun or the effects of glare were also mentioned as critical factors in survival cases. Dust, sand, and sandstorms figured in a few stories. Mirages and illusions troubled many survivors but primarily as handicaps to travel.

6. The problem of water: Few men landed with sufficient water on their person or in the aircraft to enable them to travel without considering this problem. In nearly all of the cases the men were obliged to obtain water by searching for wells, cisterns, or oases. The survivors indicated in their stories a tendency to conserve water by rationing, using a variety of rationing procedures. Men sought relief from thirst by carrying pebbles in their mouths, chewing grass and leaves and sucking juices from

snails. Emergency water supplies were purified by boiling in a few cases, although fuel for fires of any kind proved to be a desert problem.

7. Travel: Men traveled in the daytime and at night. Some tried first one time and then the other. Too many individuals traveled until they were exhausted. It was evident from the episodes studied that once a man dropped from exhaustion his succeeding period of travel and time before collapse became progressively shorter. The most satisfactory time for travel in most desert cases proved to be early morning and late evening. Inability to signal or to observe surrounding terrain and the poor chances of making contact with passing vehicles or planes were objections to traveling at night. While vision was generally better during the daylight hours, the physical effects of the environment handicapped daytime travel. Frequent rest stops were indicated as desirable in the survival stories.

8. Rest: Men who traveled at night sought shelter where they could find it in the heat of the day. Shelters were found in caves, shade of trees, or rock piles. Many men indicated the advantages of burying oneself in a shallow depression. A layer of sand over the body while resting was reported to reduce water loss and, more important, to aid relaxation and allow sleep. Exhausted or extremely tired men found it difficult to sleep in the desert. Shelter was made from parachutes, blankets, and other items of equipment. Several thicknesses of parachute cloth were necessary to keep out the blowing sand during sandstorms.

9. Clothing and wearing apparel: One-piece flying suits were eminently satisfactory as desert apparel. Gloves and hats were the most desirable pieces of clothing mentioned in the survival stories, although head covering was easily improvised from parachute cloth.

Shoes and footwear proved the most vexing clothing problem of the survivor. Only the GI high-topped shoes proved to be completely satisfactory. Low shoes, tennis shoes, flying boots, sandals, all proved troublesome. Changes of socks were desired by sur-

vivors and difficulties resulted from darned socks and mended shoes. Athlete's foot apparently spread rapidly under desert conditions and proved crippling to afflicted survivors. Some men experienced difficulty in replacing their shoes due to swelling of the feet during rest stops. Men who walked barefooted had endless difficulties with abrasions and sunburn. Men who walked barefooted across alkaline swamps or salt flats reported they suffered from alkali burns.

10. Health of survivors: Desert sores which developed from minor abrasions were experienced by most of the survivors. Desert dysentery proved painful. Sunburn was particularly distressing to fair-skinned individuals, as were desert sores. The amount of previous tanning had little effect in minimizing sunburn to survivors. Sunburned hands and dryness of eyes and mucous membranes were the most common complaints.

11. Food and hunger: Men who were short on water had little, if any, desire to eat solid food. A variety of rations were available to survivors in the aircraft flown. Complaints were registered against D rations and caramel candies. Animals were used more frequently as emergency foods than were plant materials. Gazelles were used for food most commonly. Foods were rarely cooked or only partially cooked, due primarily to a lack of fuel.

12. Hazards of survival: Small insects such as flies, sand flies, and mosquitoes proved to be one of the greatest mental and physical hazards of the desert terrain. Only one man reported he saw a snake. Scorpion bites were mentioned in three episodes. Survivors saw a great many animals ranging from elephants and lions to "kangaroo mice" and lizards. While some of these could be considered dangerous, none of the animals were more than curious.

Plant spines represented the extent of hazardous plants in the desert areas. Cactus spines were difficult to remove, while spines from acacias and similar plants were removed with ease.

13. Contact with the natives: The wan-

dering tribes of the desert apparently befriended Axis and Allied survivors without prejudice. The aid rendered included supplies of water, food, and directions; hospitality for as long as 30 days and transportation were afforded more rarely. Payment for services was mentioned in only three stories. Only two accounts of thefts were reported.

14. Signaling and signal equipment: Signal equipment available to survivors was scanty and unsatisfactory. Signal fires, parachutes, signal mirrors, Very flares, and rifle shots were mentioned in the stories along with letters or marks in the terrain.

Signaling passing vehicles or attracting the attention of aircraft proved most difficult for survivors. Fires were difficult to build because of a shortage of fuel. Ground haze created an unexpected difficulty in locating a passing plane or vehicle as well as in identifying any object seen. Military activity during the period of these survival episodes was primarily in the daytime. As the survivors were likely to rest and sleep during the day, this presented a special problem of signaling. It is apparent from

this review that a special study of signaling methods is needed for desert conditions.

15. Survival training: The men who lived the survival episodes studied for this report had had little training or briefing in survival procedures. This training is given today, and many of the hazardous episodes would not be repeated. It is clear from the stories that survival training is necessary for men who will operate aircraft in desert areas. The number of men who walked away from parties and went their own way, never to be seen again, and the hasty, poorly thought out actions of others all indicate actions which should not be duplicated following current training suggestions.

16. Philosophy of survivors: The alternative to evading, following a desert emergency under wartime conditions, was that of surrendering to the enemy. This study dealt only with those men who chose to face the deserts in hopes of reaching the Allied lines. Anyone who reads their stories of successful survival under the most hazardous conditions can only conclude that while stamina, equipment, and luck all played a part, determination and courage were the primary characteristics of these men.

Six of the Best Desert Survival Episodes

1. QATTARA DEPRESSION

A bomber on a raid to Crete was badly damaged in attacks by Messerschmitt fighters. Two and a half hours later, over Africa, the plane was abandoned. Parachute landing was routine for two men but the third had trouble. Three straps of his parachute harness gave way because his quick release was not properly fastened and he was forced to hold on to one riser for his life. In this descent he had to drop his canteen. He landed on his back with such force that he was partially paralyzed for 24 hours and only able to crawl. For 3 hours he crawled over salt flats before seeking shelter in a cave for the night. He crawled another hour the next morning before he saw the pilot and navigator, and he waved his scarf and yelled to attract their attention. These two men had stayed where they landed for a good night's rest.

These three men were in serious trouble. One man was injured and they had no maps, food, or water. Southward, stretched a salty flat, and a chain of mountains ran east and west.

The navigator then mentioned that in descent the night before he had seen a flashing beacon to the northeast and felt they should look for it. The pilot stated, "I had seen rather peculiar phenomena of scintillation caused by the stars, i.e., if I placed myself in a certain position I could see the glare of a particular star circling around certain hilltops. This became strong as a beacon at times and enabled me to see my shadow by its light. This is what the navigator had seen and I forbade him to look for it." In spite of everything the navigator insisted on starting to look for this mirage beacon in the blazing sun of midday and was never seen again.

The other two men decided to find the plane at all costs and spent part of the morning searching. They rested then until evening, when they continued the search, and later found the plane at the bottom of a

gorge, 1,000 feet below them. The plane was smashed and burned and there was no trace of water in the gorge. A search for the canteen dropped during descent by one of the men was equally futile. That night was spent in a cave.

At 0300 the following day the two men started to skirt the mountains to the east, partially hoping to find the lost navigator. Six hours of this brought them to another small gorge where they again tried to find water with no success. They located a cave large enough to accommodate both of them lying side by side and rested there. Their only food that day had been aloe berries they had found in route. They covered themselves with sand in the small cave to keep cool and remained there the rest of the blazing afternoon.

It occurred to the pilot that all of these mountains were of the same height and reminded him of seacoast cliffs and that the top of the mountain represented a plateau that was really the desert floor. They spent the evening resting but at 2000 started out to find more aloe berries. In the process of this search they located a set of "tired footprints" of the missing navigator. They searched for him until 0600 and concluded he had crawled into a cave to pass the night and so gave up the search.

The fourth day was spent resting, and on the morning of the fifth day they started a 4½-hour climb to the summit, where they had a view of limitless desert stretching to the north. They plotted a course of 10 degrees, which they estimated would take them roughly to Fuka. That evening, taking directions from the stars, they walked on very slowly. They walked for an hour and rested half an hour until daylight and then spent part of the morning looking for shelter. Three more days were spent in the same pattern. During this time their supply of aloe berries ran out, but the pilot had seen some small shells which he broke open

with his teeth and from which he sucked something. The smell was putrid and caused him to vomit but by the following day, with nothing else available, he was able to withstand the smell and keep the juices on his stomach. A very minute quantity of water was in each shell and he found that 30 of them would give thirst satisfaction for an hour or more.

On the sixth day the supply of shells ran out. They could then find nothing but empty ones which the birds had eaten.

Earlier that morning the radio operator had had a premonition they would meet someone that day but the pilot held out little hope when told about it. However, they began to walk faster in hopes of finding more snails ahead, and about the time they felt they should stop and look for shelter from the sun they saw ahead the forced landing strip of BLANK Squadron. Here they were given real water and taken back to their base in an ambulance. The navigator was never found.

2. SOUTH OF TOBRUK

A Wellington II with engine trouble crash-landed between Tobruk and Matruh with one man suffering from face injuries. The crew had in the plane four water bottles, one thermos flask, six tins of tomato juice, in addition to some iron rations. For emergency equipment they had one signal mirror, two parachutes, one map, one axe, one compass, two first-aid kits, one Very pistol, and two flashlights. They walked south the rest of that night after burning the plane and carrying the secret documents with them. The latter they tore in small pieces and buried in three different locations in route. At 1710 they located a pile of rocks which proved to be Bir el Darwell, and here they found a cistern of dirty water. They rested that first night near the well and at 0930 the following morning started walking southeast to the Qattara Depression. By 1215 the air and the sand were too hot to continue. Having no shade, they covered their heads with helmets and jackets and stretched out on the sand. By 1500 the heat was unbearable and they concluded they would be better off walking. Their water ration during this first day was one mouthful per man per hour. Parachutes were cut up for head and foot protection. The heat had had its effects, and the men were all weak and progress was very slow. In the late afternoon they saw a pole which proved to indicate Bir el Qattirini. Here, too, the water was dirty, but they drank anyway. They rested until evening in the shade of a pile of rocks. Once it be-

came cooler they built a fire and boiled 7 gallons of water and made 3 pints of tea. One man who had collapsed with heat exhaustion was treated with wet rags made from the parachute and soaked in the water of the cistern. For some reason the captain issued quinine tablets to all men at this point, and they decided to spend the night in this location. During the early morning hours the sound of passing planes awoke the men and Very flares were fired without acknowledgement. They decided then to go in the direction of the planes. After a breakfast of three biscuits each and one-sixth of a can of bully beef, they started off carrying a 2-gallon drum of boiled water, three additional bottles of boiled water, and five bottles of unboiled water. They walked until 1200, when they dropped from exhaustion. With no shade, they spread a parachute and all crawled under it. The heat of the afternoon took its toll and by 1600 they could only crawl and their lips were cracked and swollen. Two men needed additional water, so one can of tomato juice was diluted and passed around the crew.

At 2100 they started walking again, but in 1 hour they had covered only 2 miles and one of the crew was near collapse. A 2-hour rest was ordered by the captain. At 2400 they started again, this time walking for 20 minutes and resting for 10. They were exhausted at 0200 and another collapse required another rest stop. At 0400 they walked again for 2 hours. At this time they fired more Very flares on general principles

but sighted no one. A short while later they found an old gun emplacement where they could make a shelter, and a crashed plane added several cans of bully beef to their supplies.

They tried again to walk in the heat of the day but devoted most of their energy to searching for more water. Fortunately one man discovered an unmarked hole in the ground which proved to be a cistern. A knotted rope led into the hole and the strongest man in the party descended into the well hand over hand. Here he found an underground cavern with three pools. The rest of the party descended or were lowered into the cavern where it was cool. They swam in one pool and drank their fill from another. At noon it became so cool that one

man came out of the cave to get their parachutes for warmth. It was at this time that he saw a passing group of Arabs. Two Arabs agreed to return to El Alamein and return with camels to take the party out, but when the Arabs had departed the stranded crew discovered the Arabs had stolen some of their supplies. They were not sure then whether the Arabs would return. Later in the day when the men again climbed from their cavern they discovered a plane was searching for them. They signaled with Very flares and the plane, a Baltimore, landed in the desert. Two of the crew of six men were too weak by this time to climb from the cistern and had to be aided. All six men were taken aboard the Baltimore and flown back to Wadi Natrum.

3. PARALLELING THE COASTAL ROAD

Four men were forced to bail out of their aircraft after it was damaged by enemy action. Two of the men were injured in landing. The group assembled and decided to evade and walk east paralleling the coastal road. Their supplies consisted of 3 bottles of water, 6 tins of beef, 16 packets of biscuits, malted milk tablets, gum, toffee, matches, benzedrine, and a compass.

The first day was spent exploring their location and treating their wounds. They found a cairn-marked tank of rainwater during this period and drank as much as they could. The second day, after a night's rest, they started walking and continued to walk by day through the fourth day. During this time they suffered from the heat and their flying boots, which were extremely uncomfortable as hiking shoes, began to go to pieces. By the fifth day they changed their plans and started walking at night; however, the loose rock provided poor footing at night and they suffered further foot troubles. The sixth day one man collapsed and was left behind. A bad foot contributed to his difficulties. On the eighth day another man dropped behind and after waiting 24 hours headed for the coastal road and surrendered himself. The two remaining men endured an intense sandstorm on the tenth

day and on the fourteenth day, a torrential rainstorm. The fifteenth day they came to the Qattara Depression and spent 1 day walking along the edge. Going was very hard and the following day they descended to what looked like smoother sands in the valley. They spent the seventeenth day crossing the salt lake in the Depression and found, instead of smooth sand, waves of salty ridges 18-24 inches apart. They were exhausted after a short time of this type of walking and found it impossible to sleep. On the eighteenth day they met a group of Arabs who supplied them with camel's milk and water and hard bread. The bread caused them "unbearable attacks of indigestion." By the twentieth day they were much weaker. Their shoes, which had been wired together, began to come apart. The hard salty sand gave way to a thin crust of salt over mire, and they found they were breaking through and sinking into the alkali mud on every step. Later that day they met some Bedouin who supplied them with some dates, and the following day another group of Bedouin gave them rice and camel's milk diluted with water. The twenty-second day they reached a Bedouin camp where they had a meal of dates, rice cooked in oil, and some very salty water to drink.

On the twenty-fourth day they had about crossed the Qattara Depression when they came to a large salt lake. This they were forced to circle and during this trek they found the mosquitoes unbearable. Later

that day, at the north end of this salt lake, they met a British patrol and were taken to a base hospital.

They had walked 300 miles in their 24-day survival episode.

4. ETHIOPIA

A plane from the South African Air Force 12th Bomber Squadron crash-landed 20 miles inside Ethiopia, in the southern desert region. The six men aboard found they had only $2\frac{1}{4}$ gallons of water, with little chance of finding more in that desert terrain. They walked all the rest of the day, navigating by compass, only to learn from the stars at night that the compass had been deflected by the ironstone in the area and they were south of their intended course.

The second day they continued to walk over alternating stretches of lava boulders and soft sand. The heat was overpowering and they found they could walk but 15 minutes at a stretch. By mid-afternoon they had covered only 10 miles, so they rested till sundown in the shade of an isolated tree. At sundown they started walking again, but collapse came after an hour and a half and they spent the night in the open.

At dawn they started again, with the hopes of reaching a hill they had agreed on in the distance. The hill proved to be a mirage and by 0930 they were again exhausted. They waited until 1730 and tried walking again, only to give up in an hour when one man collapsed.

At this point they were down to 6 pints of water and so they decided the three

strongest men would start ahead hoping to get aid, and the three weaker individuals would come as best they could. The water was divided and the three strong men started off. They were never seen again.

The slower three continued walking 100 yards at a time and resting. They made one can of corn do for four meals but found additional food by shooting a crow and eating it half roasted. Their supply of water was exhausted and their tongues had started to peel. In this poor condition they struggled on for 4 days. When they found a small tree on the fifth day they rested in its shade for 48 hours. When the sun shifted and the shade moved, they moved with it.

After 2 days of rest they decided to try walking again, this time for 10 minutes at a time. After three spells of walking, one man collapsed and they decided to return to their lone tree. It was here on the tenth day of their survival episode they succeeded in attracting the attention of a passing plane. The plane circled and dropped five containers of water. All five broke, and they rescued only one-quarter of one of the containers. A package of bread dropped to them proved useless, for their dry throats refused the morsels. Later that day they were rescued.

5. SOMALILAND

A bomber on a photo reconnaissance flight was shot down near Afmadu north of Kis-mayu Harbor. The plane made a successful crash landing in the thorn shrub and the crew of three, after burning the plane, started to walk to the border some 62 miles away.

They walked all night through the thorn brush and rested in the scrawny shade of some acacias the following day. By sunset of the second day their water supply was

exhausted. Not wanting to proceed without water they spent 2 days trying to find a water hole. Thirst got the best of them during this period and they resorted to moistening their lips with alcohol from the compass. On the sixth day they succeeded in finding a water supply, but by this time their lips were blistered and swollen. The small amount of water enabled them to walk on and they found a better supply of water in another hole. At this one they filled

the canvas covering of their first-aid kit as an improvised canteen. That night they were forced to scare away prowling lions with Very flares.

On the seventh day they again ran out of water and did not locate any more until the tenth day. By this time one man was exhausted and another sick from the heat. The third man decided to try and find aid alone. His instructions to the others were to wait 3 days at that water hole for his return and after that they were on their own.

This single man filled his water bottle and started off. He walked through the night until 1000 the next morning, when he collapsed from exhaustion. Eventually he recovered enough to walk on and later that day he met two natives who gave him some goat's milk and led him to a water hole. There he fell asleep, and when he awoke the natives were gone. He decided to remain there and rest, and later that day the natives returned with a camel. While riding the camel he was spotted by a passing plane and was met a few hours later by a truck.

He learned he had walked 50 miles in 24 hours after leaving his companions.

The two men at the water hole had no food but had adequate shade and water. They tried to catch birds with birdlime they made by chewing sticky succulent plants they found, and even improvised a bow and arrow from shoestring and branches. They had no success catching game and the land was so scorched by the heat they could not even find grass to chew on.

When the rescue party had not arrived by the end of the third day they decided to proceed in the same direction the single man had taken. One night was spent in a hyena's den. The following day they found an owl's nest and ate the eggs, which contained half-developed embryos. They continued on during the fifteenth day of their episode, only to collapse from exhaustion about midday. At this point they gave up all hope of reaching safety or of being rescued and watched the vultures circling over the small patch of shade in which they lay. It was these same vultures seen by the search party that led to their rescue a short time later.

6. ARIZONA

A marine fighter pilot on a routine flight over the Arizona desert bailed out of his plane when the engine caught fire. Although he landed only 25 miles from a large Army base, he wandered for 4 days before he was found. This is his story.

"While on the last leg of a routine navigation flight my engine began vibrating and smoking. My division leader instructed me to bail out. The parachute opened promptly and afforded an easy descent. On landing I opened the parachute to its full extent and pinned it down with rocks so that it could be seen by searching planes. I then decided to go to the scene of the crash hoping that parts of the plane were still on fire and I could start a signal. I had no matches with me, in fact I had nothing other than a flying suit and a wrist watch.

"The plane crashed approximately 500 yards away. The fire was completely extinguished by the time I arrived on the scene.

I then started back to where I thought I left the chute but was unable to locate it. Some Corsairs a mile away seemed to be zooming the chute and while hastening in that direction I noticed a Taylor Cub come down for a landing. I was still too far away to see it actually land. I don't think I was over 400 feet away when it took off. I yelled but was unable to attract attention.

"After wandering around the area in search of water for about an hour I made for some hills which were due west. The time was about 1600 and I decided to get out of the sun and rest for a while. Having recently seen the training film 'Castaway,' I remembered to keep my flying suit fastened up and my helmet on as protection against the sun. Locating some rocks which formed a square I dug out the soft earth from the center with my hands and made a bed.

"I slept until 0400 at which time I got up and started looking for some water. I was

very thirsty at this point. I recalled reading an article at one time which said that cacti contained water. I experimented with several types and found a small barrel type was the best suited for my purposes. I bashed in the top of it with an empty K ration can which I had picked up along the way. The pulp contained a great deal of moisture. After quenching my thirst I filled the inside pocket of my flying suit with the pulp. This proved to be a wise move as this particular species of cactus was not readily located.

"Figuring that my chance of being picked up would be in the vicinity of the wreck I doubled back but was unable to find it. I could see planes searching the area. I tried everything I could think of to attract their attention. I polished the bottom of my K ration can and tried using it as a mirror; I also made a flag of my undershirt and waved that to no avail.

"When it became apparent that the searching planes were unable to spot me from the air I decided that the best course was to strike out on my own. After placing my initials in the sand in letters 30 feet high along with a note I was heading west I struck out for a mountain peak I had noticed at sunset the night before.

"I walked for a couple of hours and then lay down under a dead tree. I kept thinking that if only I could start a fire my chances of being rescued would be so much better. I tried using my goggles to focus the sun's rays, tried striking stones together, and

finally the bow socket method. I walked for several hours that night and then made a bed in the sandy area.

"Up at dawn on the third day I was successful in finding another cactus plant and in replenishing my pocket supply. I kept walking and on this day made the mistake of walking through the desert heat. My eyes began playing tricks on me and suddenly I found myself falling. Although I fell a considerable distance over the side of the hill I sustained no injury other than a bruised wrist. I slept for a while in the afternoon and continued walking in the evening. That night I again made a bed of sand.

"On the fourth day I really began to feel the pains of hunger and thirst. While resting in the shade I saw a brown lizard on a nearby branch. This I killed and skinned with my belt buckle which I had sharpened, and devoured. At the same time I caught a large fly and after stripping off the wings and legs I ate that, too. That night I again slept on a sand bar.

"At daybreak on the fifth day I made my way to the top of a hill and found an artillery marker. Looking back, I found a Taylor Cub searching the area I had just covered, and as the plane approached I signaled by pushing the marker back and forth. The pilot acknowledged by dipping his wings and then dropped a canteen and a note to stay there. Later an ambulance drove up. I lost 35 pounds but suffered no other ill effects."